Name	Class	Index Number

PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination

PHYSICS **8866/01**
Higher 1

Paper 1 Multiple Choice

22 September 2017

Additional Material: Multiple Choice Answer Sheet **1 hour**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces 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 rough working should be done in this booklet.

This document consists of **16** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

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,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + ...$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + ...$

1 What is a reasonable estimate of the energy of a photon of yellow light?

A 1.6×10^{-19} J

B 2.8×10^{-19} J

C 3.6×10^{-19} J

D 5.0×10^{-19} J

2 A bus accelerates uniformly from rest and travels a distance of (50.4 ± 0.5) m in a time of (8.4 ± 0.2) s.

What is the acceleration of the bus together with its associated uncertainty?

A (1.4 ± 0.2) m s^{-2}

B (1.4 ± 0.7) m s^{-2}

C (1.43 ± 0.05) m s^{-2}

D (1.43 ± 0.08) m s^{-2}

3 The speedometer in a car consists of a pointer which rotates. The pointer is situated several millimetres from a calibrated scale.

What could cause a random error in the driver's reading of the car's speed?

A The car's speed is affected by the wind direction.

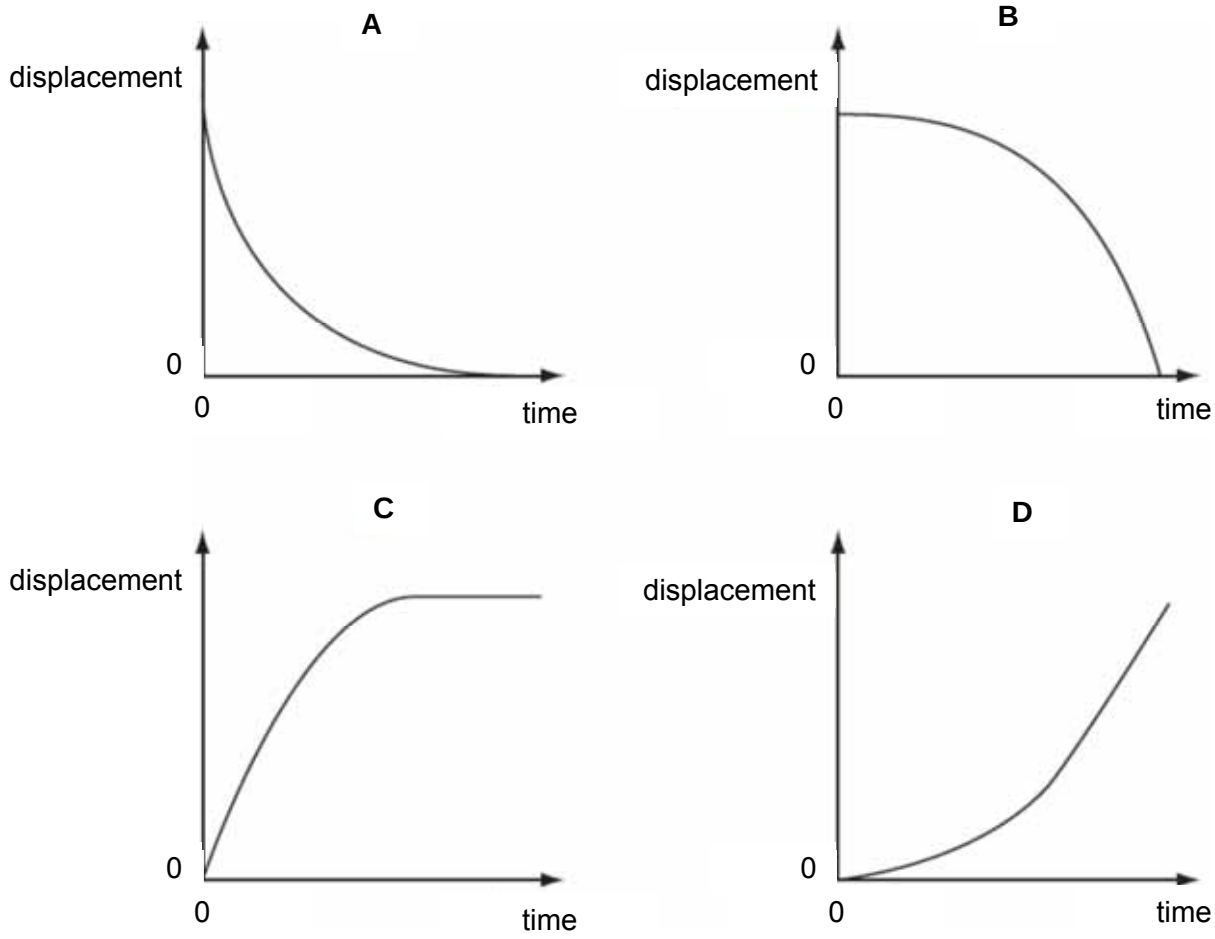
B The speedometer does not read zero when the car is at rest.

C The speedometer reads 5% higher than the car's actual speed.

D The driver's eye is not always in the same position in relation to the pointer.

4 An object is released from rest and falls vertically. Its initial acceleration decreases until it eventually reaches terminal velocity.

Which graph best represents how the displacement of the object varies with time?



5 The acceleration of free fall on Earth is six times of that on Moon.

It takes time *t* for a rock on Moon to fall a distance of 3.0 m from rest.

What is the time taken for a rock on Earth to fall a distance of 2.0 m from rest?

A $\frac{t}{9}$

B $\frac{t}{4}$

C $\frac{t}{3}$

D $\frac{t}{2}$

6 A ball is thrown across a flat ground.

Which statement describes the motion of the ball, when the effects of air resistance are negligible?

A The ball lands with the same velocity at which it is thrown.

B The velocity of the ball is zero at the highest point of the motion.

C The vertical acceleration of the ball is zero at the highest point of the motion.

D The horizontal and vertical components of acceleration are constant throughout the motion.

7 Water is pumped through a hose-pipe at a rate of 5100 kg per hour. It emerges from the hose-pipe horizontally with a speed of 15 m s^{-1}.

What is the force required from a person holding the hose-pipe to prevent it from moving backwards?

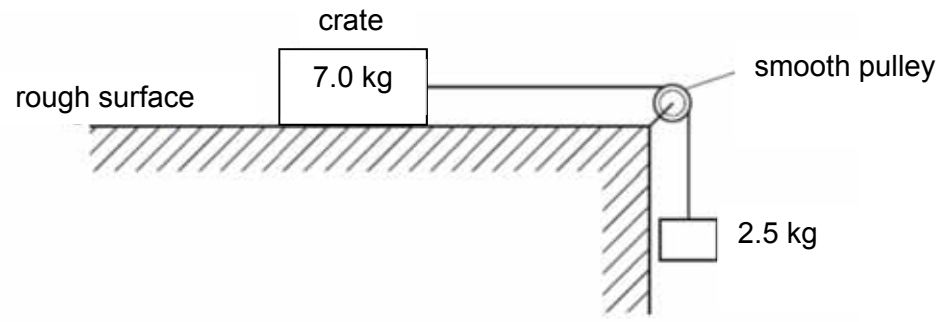
A 11 N

B 21 N

C 340 N

D 77000 N

8 A crate of mass 7.0 kg rests on a rough horizontal surface. A light string attached to the crate passes over a smooth pulley and supports a load of mass 2.5 kg at its other end.



When the crate is released, a frictional force of 5.0 N acts on it.

What is the acceleration of the crate?

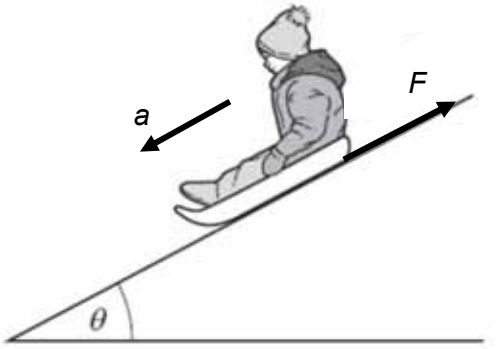
A 2.1 m s^{-2}

B 3.1 m s^{-2}

C 4.5 m s^{-2}

D 9.8 m s^{-2}

9 A child on a sledge slides down a slope with acceleration *a*. The slope is inclined at angle *θ* above the horizontal.



The mass of the child is *m* and the mass of the sledge is *M*. The acceleration of free fall is *g*. Ignore the effects of air resistance.

What is the frictional force *F*?

A $m(g\cos\theta + a)$

B $m(g\sin\theta - a)$

C $(m+M)(g\cos\theta - a)$

D $(m+M)(g\sin\theta - a)$

10 Two lorries of masses m and $2m$ travel towards each other in opposite directions with speeds $2v$ and v respectively. The lorries make a head-on collision and coalesce.

What is the speed of the lorries after collision?

A 0

B $\frac{3}{4}v$

C v

D $\frac{4}{3}v$

11 A beam of electrons is directed horizontally into a vertical downward field of force.

Which row shows the possible nature of the force acting on the beam with the correct path of the beam?

	force	path of beam
A	gravitational	horizontal
B	electric	curve upwards
C	gravitational	vertically downwards
D	electric	vertically upwards

12 The density of liquid Q is twice that of liquid R.

In liquid R, the pressure at depth x is 4.0 kPa.

What is the depth in liquid Q where the pressure is 7.0 kPa?

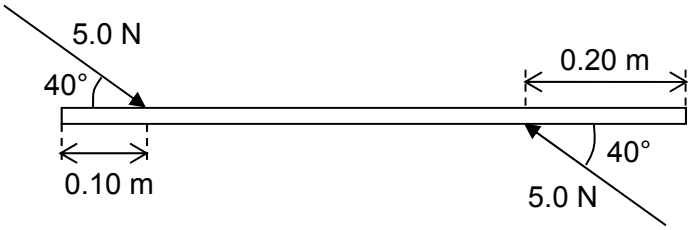
A $\frac{2x}{7}$

B $\frac{7x}{8}$

C $\frac{8x}{7}$

D $\frac{7x}{2}$

13 Two forces of magnitude 5.0 N act on a plank of length 0.90 m. The forces are parallel and act in opposite directions as shown.



What is the torque of the couple?

A 1.9 N m

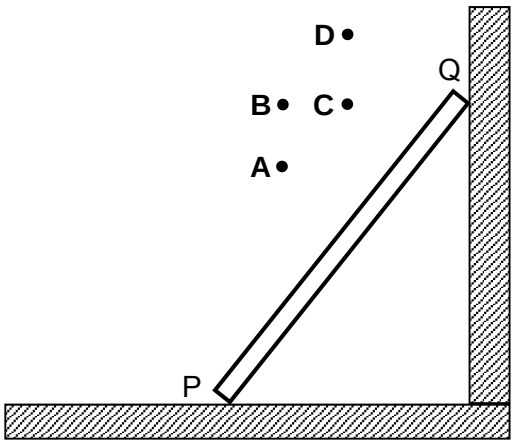
B 2.3 N m

C 2.9 N m

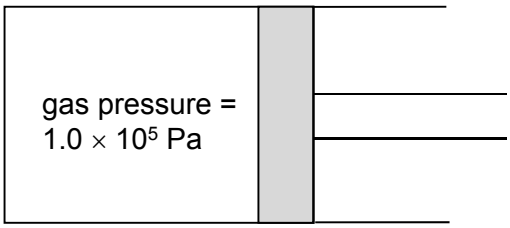
D 3.4 N m

14 The diagram shows a non-uniform plank PQ resting against a wall. The resultant forces at P and Q are F_P and F_Q respectively.

If the plank is in equilibrium, which point must F_P and F_Q act through?



15 A gas of pressure 1.0×10^5 Pa is enclosed in a cylinder fitted with a gas-tight, frictionless piston of cross-sectional area 32 cm^2. The gas is heated and the piston moves a distance of 6.0 mm outwards in order to keep the pressure of the gas constant.



What is the work done on the gas?

A -1.9×10^7 J

B −1.9 J

C 1.9 J

D 1.9×10^7 J

16 Trains supply coal to a power station. The table below gives quantities describing the operation of the power station.

	symbol	unit
power station output	*P*	W
number of trains per day	*N*	
mass of coal on a train	*M*	kg
energy from 1 kg of coal	*J*	J
number of seconds in one day	*S*	

Which expression gives the efficiency of the power station?

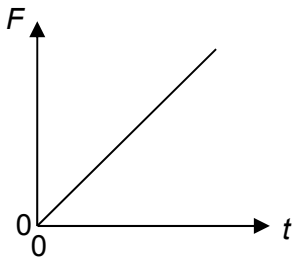
A $\frac{NM}{PSJ}$

B $\frac{NMJ}{PS}$

C $\frac{PS}{NMJ}$

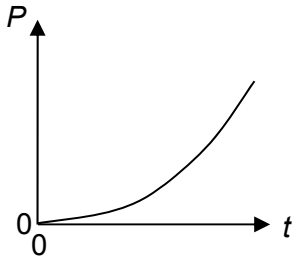
D $\frac{PSN}{MJ}$

17 The graph shows the variation with time t of the driving force F exerted by the engine on a vehicle.

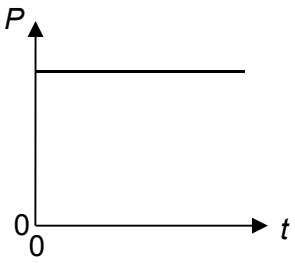


Which graph shows the variation with time t of the power P delivered by the engine?

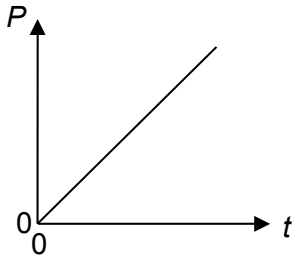
A



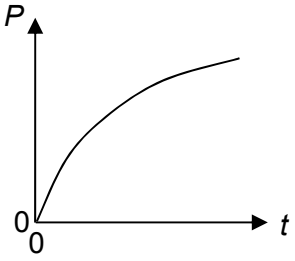
B



C



D



18 In a transverse progressive wave of frequency 200 Hz, the least distance between two adjacent points which have a phase difference of $\frac{\pi}{4}$ is 0.040 m.

What is the speed of the wave?

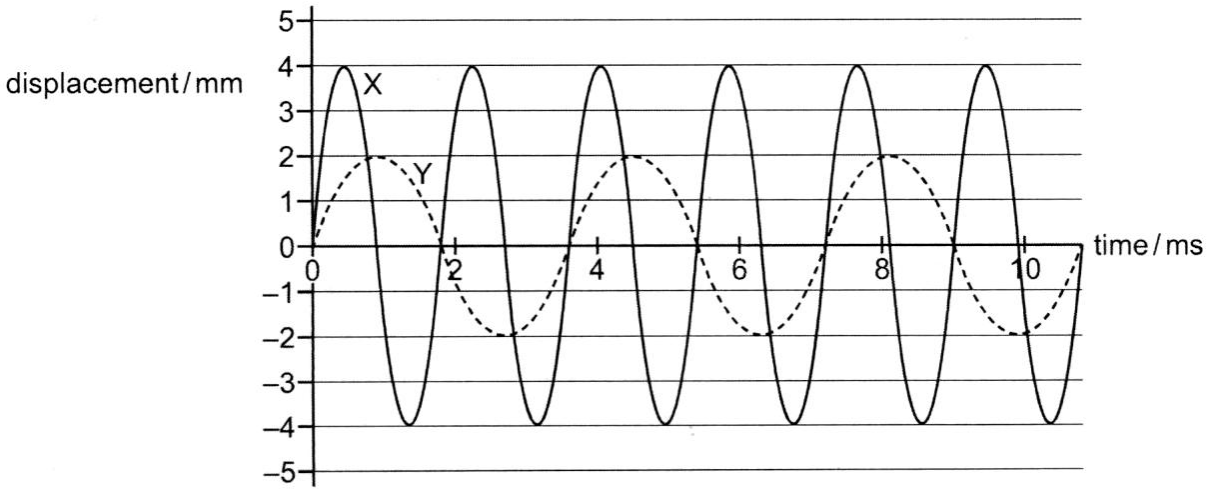
A 16 m s^{-1}

B 32 m s^{-1}

C 48 m s^{-1}

D 64 m s^{-1}

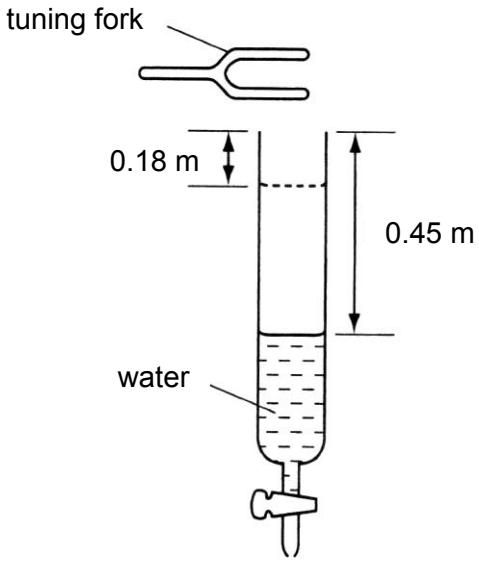
19 The graph represents two waves, X and Y.



Which row shows the frequency and intensity ratios for X and Y?

	$\frac{\text{frequency of X}}{\text{frequency of Y}}$	$\frac{\text{intensity of X}}{\text{intensity of Y}}$
A	$\frac{1}{2}$	2
B	2	2
C	$\frac{1}{2}$	4
D	2	4

20 A tuning fork is made to vibrate above a burette filled with water. The water is allowed to run out of the tube.



A loud sound is heard when the length of the air column is 0.18 m and again when the length is 0.45 m.

What is the wavelength of the sound in the tube?

A 0.27 m

B 0.36 m

C 0.54 m

D 1.1 m

21 Two coherent waves, of intensities I and $4I$ meet in anti-phase at a point.

What is the resultant intensity at that point?

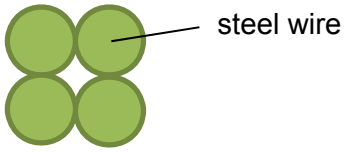
A 0

B I

C $3\,I$

D $5\,I$

22 An electrical supply cable consists of four identical steel wires arranged next to one another. Each wire has a cross-sectional area of 50 mm^2 and a resistivity of $9.0 \times 10^{-8}\ \Omega$ m. The cross section of the cable is as shown.



What is the resistance of the cable if its length is 100 m?

A $4.5 \times 10^{-8}\ \Omega$

B $7.2 \times 10^{-7}\ \Omega$

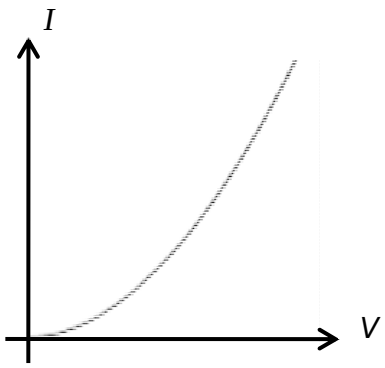
C $0.045\ \Omega$

D $0.72\ \Omega$

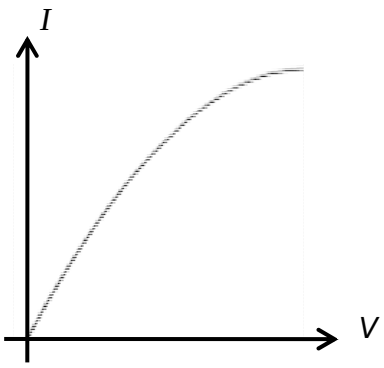
23 Some electric light bulb filaments are made of carbon. It is known that the resistance of carbon filaments decreases as their temperature increases.

Which graph shows how the current I through such a bulb varies with the potential difference V across it?

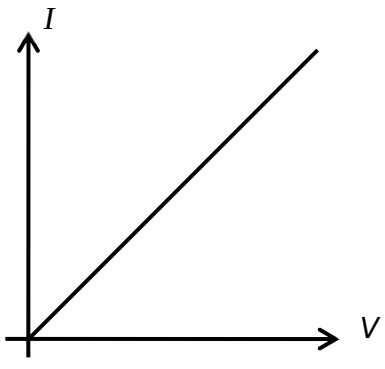
A



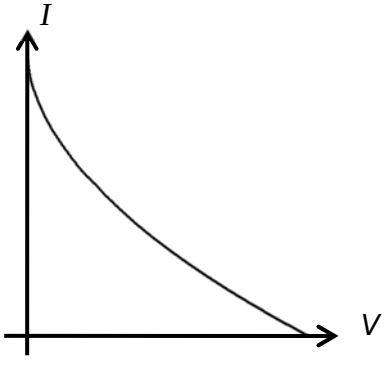
B



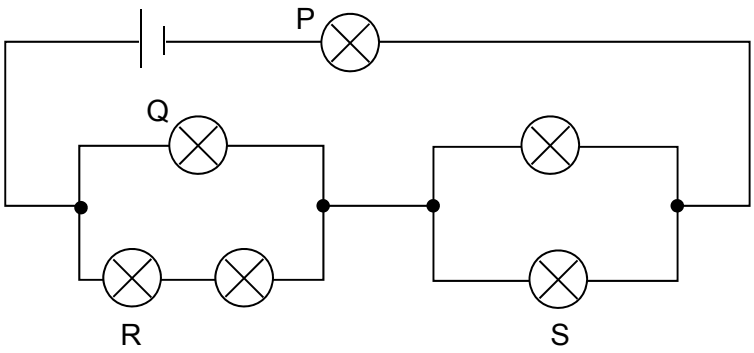
C



D



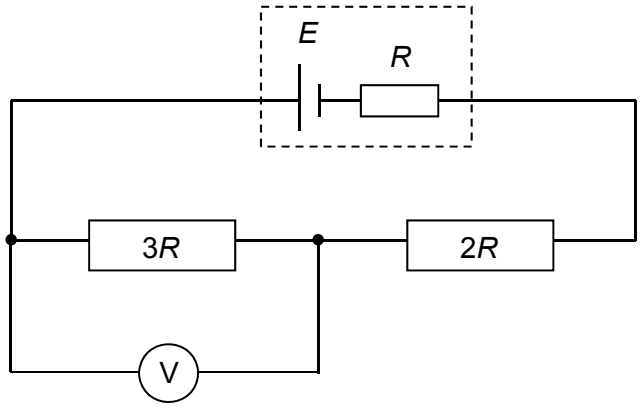
24 Six identical light bulbs are connected as shown in the diagram below.



Which are the dimmest and brightest bulbs?

	dimmest	brightest
A	P	Q
B	R	P
C	P	R
D	S	P

25 A cell of e.m.f. E and internal resistance R is connected to resistors of resistances $3R$ and $2R$. An ideal voltmeter is connected to the circuit, as shown in the diagram below.

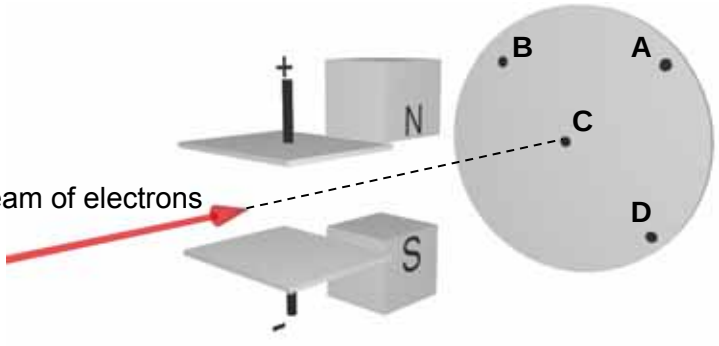


What is the reading in the voltmeter?

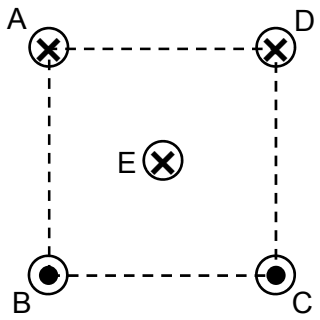
A $\frac{E}{5}$ **B** $\frac{E}{3}$ **C** $\frac{E}{2}$ **D** $\frac{2E}{3}$

26 A beam of electrons passes through the centre of a pair of parallel plates connected to a power source, with the polarity as shown, and a pair of permanent magnets.

Which is the likely position that the beam will end up on the screen?



27 Four parallel conductors A, B, C and D, carrying equal currents, pass vertically through the four corners of a square. In conductors A and D, the current is flowing into the page, and in conductors B and C, current is flowing out of the page.



Which of the following **incorrectly** describes the resultant force on conductor E, with current flowing into the page, at the centre of the square?

A The resultant force due to wires A and D points towards line AD, perpendicular to AD.

B The resultant force due to wires B and C points towards line AD, perpendicular to AD.

C The resultant force due to wires B and D points towards line AD, perpendicular to AD.

D The resultant force due to wires A, B, C and D points towards line AD, perpendicular to AD.

28 The line spectrum of hydrogen includes no X-ray frequencies.

The reason for this is

A the ionisation energy is too low.

B the work function energy is too high.

C there is only one electron in a hydrogen atom.

D there are too few electronic energy levels in the hydrogen atom.

29 The de Broglie wavelength of a moving particle with kinetic energy E_k is λ.

When the kinetic energy of the particle is decreased to $\frac{E_k}{2}$, its de Broglie wavelength is

A $\frac{\lambda}{2}$.

B $\frac{\lambda}{\sqrt{2}}$.

C $\sqrt{2}\lambda$.

D 2λ.

30 In a photoelectric experiment, one photoelectron is ejected from the metal for every ten photons incident.

Given that the photocurrent is 2.5 μA and the frequency of the source is 6.0×10^{14} Hz, what is the power of the source?

A 2.4×10^{-9} W

B 8.1×10^{-7} W

C 6.2×10^{-5} W

D 2.6×10^{-3} W

PJC Answers to JC2 Preliminary Examination Paper 1 (H1 Physics)

1	**C**	**6**	**D**	**11**	**B**	**16**	**C**	**21**	**B**	**26**	**A**
2	**D**	**7**	**B**	**12**	**B**	**17**	**A**	**22**	**C**	**27**	**C**
3	**D**	**8**	**A**	**13**	**A**	**18**	**D**	**23**	**A**	**28**	**A**
4	**D**	**9**	**D**	**14**	**B**	**19**	**D**	**24**	**B**	**29**	**C**
5	**C**	**10**	**A**	**15**	**B**	**20**	**C**	**25**	**C**	**30**	**C**

Suggested Solutions:

1 Wavelength of yellow light is approximately 550 nm.

$$E = \frac{hc}{\lambda}$$
$$= \frac{\left(6.63\times10^{-34}\right)\left(3.00\times10^{8}\right)}{550\times10^{-9}}$$
$$= 3.62\times10^{-19}\ \text{J}$$

Answer: C

2 Using $s = ut + \frac{1}{2}at^2$,

$$a = \frac{2s}{t^2}$$
$$= \frac{2\times50.4}{8.4^2}$$
$$= 1.429\ \text{m s}^{-2}$$
$$\frac{\Delta a}{a} = \frac{\Delta s}{s} + 2\frac{\Delta t}{t}$$
$$\Delta a = \left[\frac{\Delta s}{s} + 2\frac{\Delta t}{t}\right]a$$
$$= \left[\frac{0.5}{50.4} + 2\frac{0.2}{8.4}\right](1.429)$$
$$= \pm0.08\ \text{m s}^{-2}$$
$$a = (1.43 \pm 0.08)\ \text{m s}^{-2}$$

Answer: D

3 Option A does not affect the driver's reading of the car's speed.
Option B causes a systematic error.
Option C causes a systematic error.
Option D causes a parallax error which is a random error.

Answer: D

4 Gradient of graph gives the velocity. Graph D shows the speed of the object increasing from zero to a constant maximum value.

Answer: D

5 Using: $s = ut + \frac{1}{2}at^2$

On Moon:

$3 = \frac{1}{2}a_{moon}t^2 \quad ---(1)$

On Earth:

$2 = \frac{1}{2}(6a_{moon})t_{Earth}^2 \quad ---(2)$

Solving (1) and (2)

$\frac{2}{3} = \left(\frac{6a_{moon}}{a_{moon}}\right)\frac{t_{Earth}^2}{t^2}$

$t_{Earth} = \frac{t}{3}$

Answer: C

6 When the effects of air resistance are negligible, the horizontal component of velocity of the ball is constant. Hence horizontal component of acceleration is zero.
The vertical component of acceleration of the ball is constant and has the same value as the acceleration of free fall.

Answer: D

7 $\text{force} = \Delta v \frac{dm}{dt}$

$= 15\left(\frac{5100}{60 \times 60}\right)$

$= 21\ \text{N}$

Answer: B

8 Let tension in string be T

For crate: $T - 5.0 = (7.0)a$ ..... (1)

For 2.5 kg mass: $(2.5)(9.81) - T = (2.5)a$ ..... (2)

(1)+(2):

$T - 5.0 + 2.5(9.81) - T = 7.0a + 2.5a$

$a = 2.1\ \text{m s}^{-2}$

Answer: A

9 Resultant force $= (m + M)a$

$(m + M)a = (m + M)g\sin\theta - F$

$F = (m + M)g\sin\theta - (m + M)a$

$= (m + M)(g\sin\theta - a)$

Answer: D

10 Using the principle of conservation of momentum,

$m(2v) - 2m(v) = 3m(v_f)$

$v_f = 0$ m s^{-1}

Answer: A

11 The beam of electrons will follow an upward parabolic path if the electric field is directed vertically downward.

Answer: B

12 For liquid R, 4 kPa $= \rho g x$

For liquid Q, 7 kPa $= 2\rho g h$

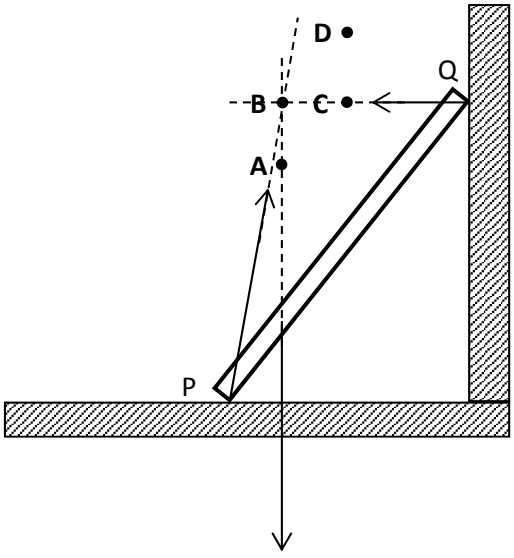
$h = \dfrac{7x}{8}$

Answer: B

13 Torque of couple $= (5.0)(0.60\sin 40°) = 1.9$ N m

Answer: A

14



Answer: B

15 Work done by gas against external pressure of 1.0×10^5 Pa

$= \left(1.0 \times 10^5\right)\left(32 \times 10^{-4}\right)\left(6.0 \times 10^{-3}\right) = 1.9$ J

Work done on gas = −1.9 J

Answer: B

16 Energy output = *PS*

Energy input = *NMJ*

Efficiency of power station $= \dfrac{PS}{NMJ}$

Answer: C

17 $P = Fv = F(u + at) = (kt)(u + \dfrac{kt}{m}t) = kut + \dfrac{k^2}{m}t^3$

P increases at an increasing rate.

Answer: A

18

$$\frac{\Delta x}{\lambda} = \frac{\Delta \phi}{2\pi}$$

$$\frac{0.040}{\lambda} = \frac{\pi/4}{2\pi}$$

$$\lambda = 0.32 \text{ m}$$

$$v = f\lambda$$

$$= (200)(0.32)$$

$$= 64 \text{ m s}^{-1}$$

Answer: D

19 From the graph, the period of Y is 2 times the period of X. Therefore, $\dfrac{f_X}{f_Y} = 2$

$I \propto A^2$

$\dfrac{I_X}{I_Y} = \dfrac{4^2}{2^2} = 4$

Answer: D

20 First resonance is $\dfrac{1}{4}\lambda$, while second resonance is $\dfrac{3}{4}\lambda$.

Difference in the length = 0.45 – 0.18 = $\dfrac{1}{2}\lambda$.

Therefore, wavelength of the sound wave is 0.54 m.

Answer: C

21 $I \propto A^2$

Since waves are in anti-phase → resultant amplitude is *A*. Therefore intensity is I.

Answer: B

22

$$R_{wire} = \frac{\left(9.0 \times 10^{-8}\right)(100)}{\left(50 \times 10^{-6}\right)} = 0.18\ \Omega$$

Wires are in parallel,

$$R_{cable} = \frac{0.18}{4} = 0.045\ \Omega$$

Answer: C

23 The resistance of the filament drops for higher values of I and *V*. Hence, the ratio of I/*V* must increase for higher values of I and *V*.

Answer: A

24 The bulb with the lowest current flowing through it will have the dimmest. R has the least current and P has the largest current. Hence, R is the dimmest and P is the brightest.

OR

If the e.m.f. of the cell is *E*, the potential difference across each of the four bulbs is in an increasing order of V_R=0.15*E*, V_S=0.23*E*, V_Q=0.31*E*, V_P=0.46*E*. The power rating of each bulb can be calculated using $P = \frac{V^2}{R}$, where the resistance of each of the bulb is the same. Hence bulb R has the smallest power rating (hence dimmest) and bulb P has the largest rating (brightest).

Answer: B

25 By potential divider concept,

Voltmeter reading = $\frac{3}{3+2+1}(E) = \frac{E}{2}$

Answer: C

26 The electrons are deflected upwards towards the positive plate and towards the right by the magnetic force.

Answer: A

27 For option C, the resultant force points towards conductor D.

Answer: C

28 The energy of a photon of X-ray is much higher than the ionisation energy of hydrogen (13.6 eV).

Answer: A

29 Since $E_k = \frac{p^2}{2m}$, we have $E_k = \frac{h^2}{2m\lambda^2}$.

$E_k \propto \frac{1}{\lambda^2}$ ----- (1)

$\frac{1}{2}E_k \propto \frac{1}{\lambda'^2}$ ----- (2)

Solving (1) and (2), we have

$\frac{E_k}{\frac{1}{2}E_k} = \frac{\lambda'^2}{\lambda^2}$

$\lambda' = \sqrt{2}\lambda$

Answer: C

30 Power of source = $n_1 h f$ where n_1 is the no. of photons arriving per second.
Current $I = n_2 e$ and n_2 is the no. of electrons emitted per second

$$n_2 = \frac{I}{e}$$

Given that $\frac{n_1}{n_2} = 10$, $n_1 = 10 n_2$

Thus power of source = $10 n_2 hf$

$$= 10 \frac{I}{e} h f$$

$$= \frac{10(2.5\times10^{-6})(6.63\times10^{-34})(6.0\times10^{14})}{1.6\times10^{-19}}$$

$$= 6.22\times10^{-5}\,\text{W}$$

Answer: C

Name	Class	Index Number

PIONEER JUNIOR COLLEGE
JC2 Preliminary Examination

PHYSICS **8866/02**
Higher 1

Paper 2 Structured Questions

15 September 2017

2 hours

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer any **two** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/ 9
2	/ 6
3	/ 5
4	/ 8
5	/ 5
6	/ 7
Section B	
7	/ 20
8	/ 20
9	/ 20
Total	/ 80

This document consists of **24** printed pages.

Data

speed of light in free space,	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge,	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant,	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron,	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton,	$m_p = 1.67 \times 10^{-27} \text{ kg}$
acceleration of free fall,	$g = 9.81 \text{ m s}^{-2}$

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,	$p = \rho gh$
resistors in series,	$R = R_1 + R_2 + ...$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + ...$

Section A

Answer **all** the questions in this Section.

1 (a) A ball of mass 0.050 kg is dropped from rest onto a hard floor and bounces vertically repeatedly. The height from which the ball is dropped is measured to be 2.0 m. Assume air resistance is negligible.

(i) Determine the speed of the ball just before the first impact.

speed = ... m s^{-1} [2]

(ii) The speed of the ball decreases by 30 % just after the first bounce.

1. Determine the corresponding momentum of the ball.

momentum = ... kg m s^{-1} [2]

2. Given that the duration of the first impact is 0.10 s, calculate the magnitude of the average force exerted on the ball by the floor.

force = ... N [2]

(b) A rock climber is stranded on a ledge. The rescuer on the ground shoots a rescue kit to him. The rescue kit is directed at an initial angle of 60° above the horizontal and has a launch speed of 17 m s^{-1}. Assume air resistance is negligible.

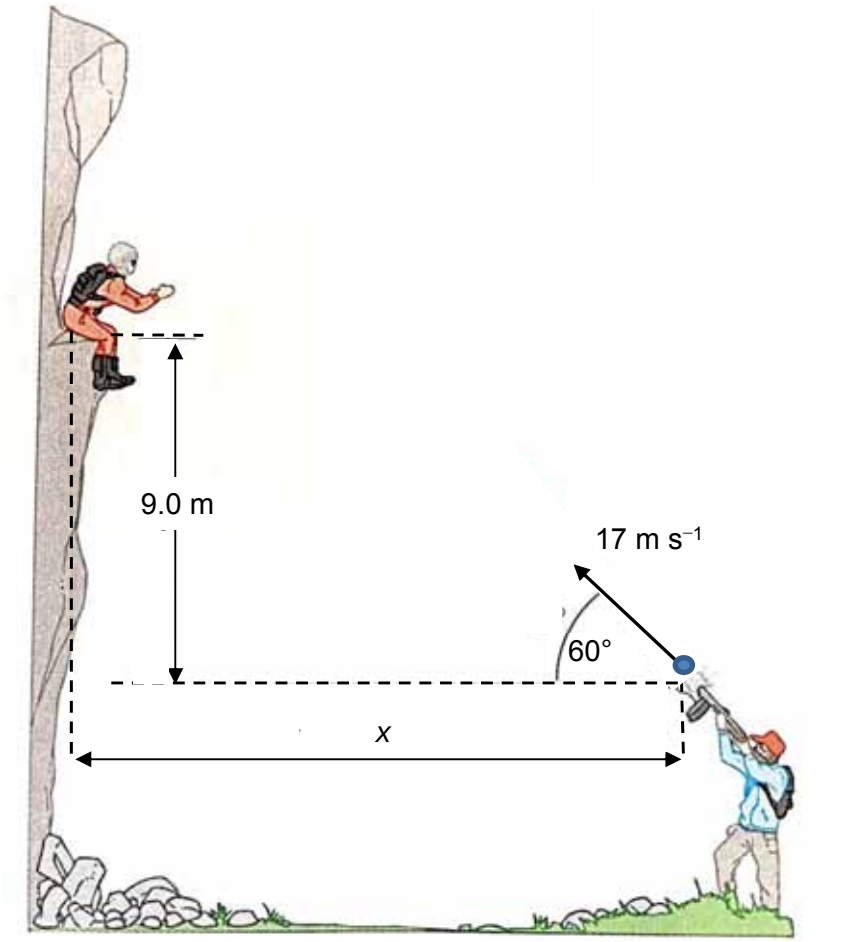


Fig. 1.1 (not drawn to scale)

(i) The kit reaches the top of its trajectory and then falls towards the climber.

Determine the time the kit takes to reach the climber.

time = ... s [2]

(ii) Hence, determine the horizontal distance x travelled by the kit.

x = ... m [1]

2 **(a)** Explain what is meant by the following terms when used in the context of forces.

(i) centre of gravity: ……

.....

..... [1]

(ii) torque of a couple: ……..

.....

..... [1]

(b) Fig. 2.1 shows a uniform metal beam PQ pivoted on a vertical wall at P and held in equilibrium by a cable attached to Q.

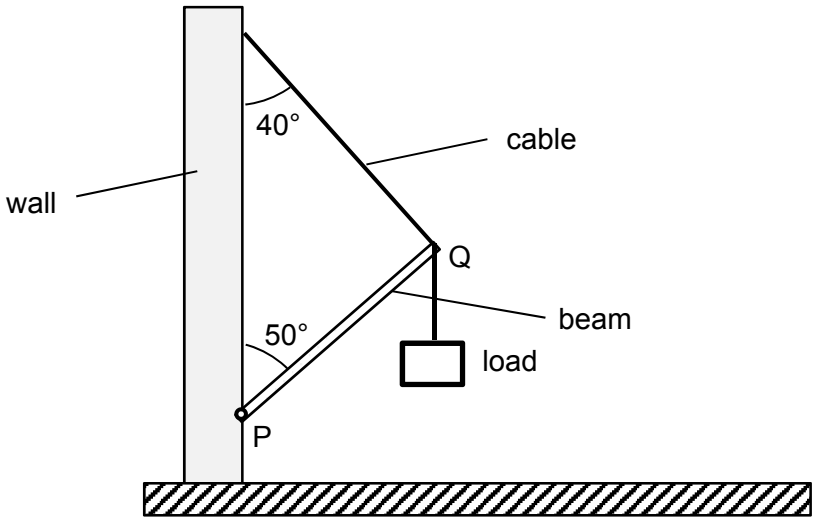


Fig. 2.1

The beam makes an angle of 50° with the wall and the cable makes an angle of 40° with the wall. The beam has weight 600 N and length 2.8 m. A load of 4000 N is hung from Q.

(i) By taking moments about P, calculate the tension in the cable.

tension = ... N [2]

(ii) A force acts on the beam at P.

Explain why a force is required to act on the beam at P to keep the beam in equilibrium.

.....

.....

.....

..... [2]

3. Light is polarised when it passes through a sheet of material known as polaroid.

Three parallel sheets of polaroids P, Q and R are placed close to each other. The polarising axis of each polaroid is shown by an arrow. The polarising axis of Q and R are at 30^o and 45^o respectively, to that of P, as shown in Fig. 3.1.

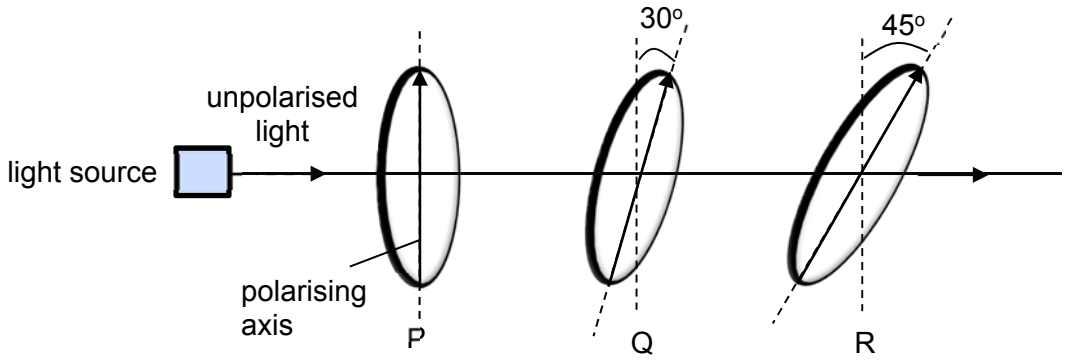


Fig. 3.1 (not drawn to scale)

A parallel beam of light is incident normally on P. The beam after emerging from P has amplitude *A* and intensity I.

(a) State what polarisation suggests about the nature of light.

..... [1]

(b) Determine the amplitude of light that emerges from R in terms of *A*.

amplitude = ... *A* [2]

(c) Hence, determine the intensity of light that emerges from R in terms of I.

intensity = ... I [2]

4 The wavelength of the monochromatic light from a source can be determined using the experimental setup as shown in Fig. 4.1. The slit separation *a* is 0.030 mm and the distance between the double slits and the screen *D* is 1.2 m.

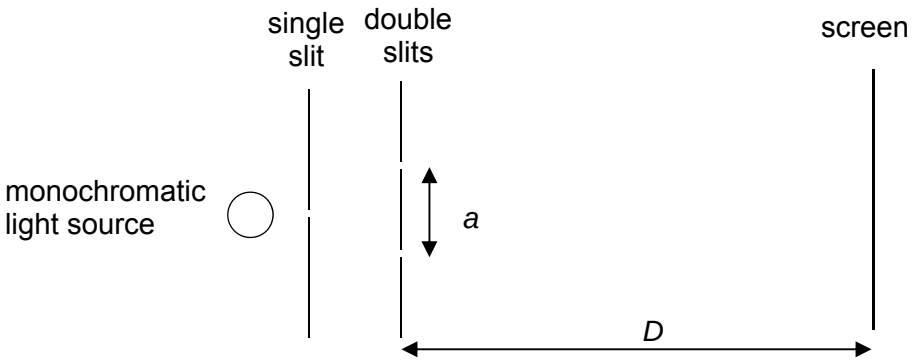


Fig. 4.1

When the monochromatic light is incident on the slits the separation of the bright fringes on the screen is 1.7 cm.

(a) Calculate the wavelength of the monochromatic light source.

wavelength = ... m [2]

(b) The following changes are made independently. Describe, in each case, the effect of the changes on the fringe separation and on the contrast between dark and bright fringes.

(i) The distance *D* is increased to 2*D*, keeping *a* and λ constant.

.....

..... [2]

(ii) The monochromatic light source is changed to red light, keeping *a* and *D* constant.

.....

..... [2]

(iii) A polariser is placed between the single slit and the double slits.

.....

..... [2]

5 A cell of e.m.f 10 V and internal resistance 0.50 Ω is connected to a light-dependent resistor (LDR), as shown in Fig. 5.1. The LDR is found to have resistance 800 Ω in the dark and resistance 160 Ω in the daylight.

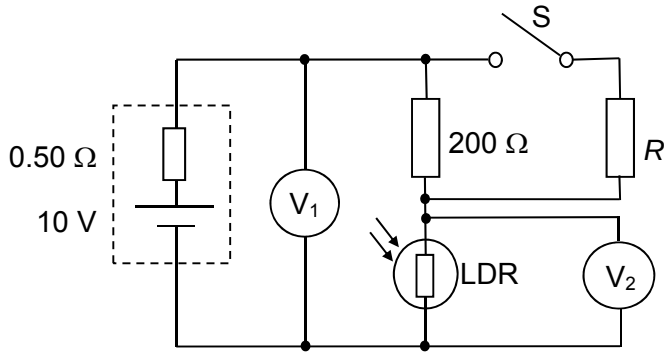


Fig. 5.1

(a) Explain why the reading of voltmeter V_1 is less than the e.m.f. of the cell.

.....

..... [1]

(b) When switch S is open in the dark, show that the reading of voltmeter V_2 is 8.0 V.

[1]

(c) When switch S is closed in daylight, the voltmeter V_2 reads the same value in **(b)**.

Calculate the value of the resistance *R*.

R = ... Ω [3]

6 In a railway station, the timetable for trains running between towns is given in the form of a distance-time graph. A modified part of the graph for the times between 0800 hr and noon is shown in Fig. 6.1. Trains run between town A and town H with six intermediate stations. For example, train R runs from town G to H.

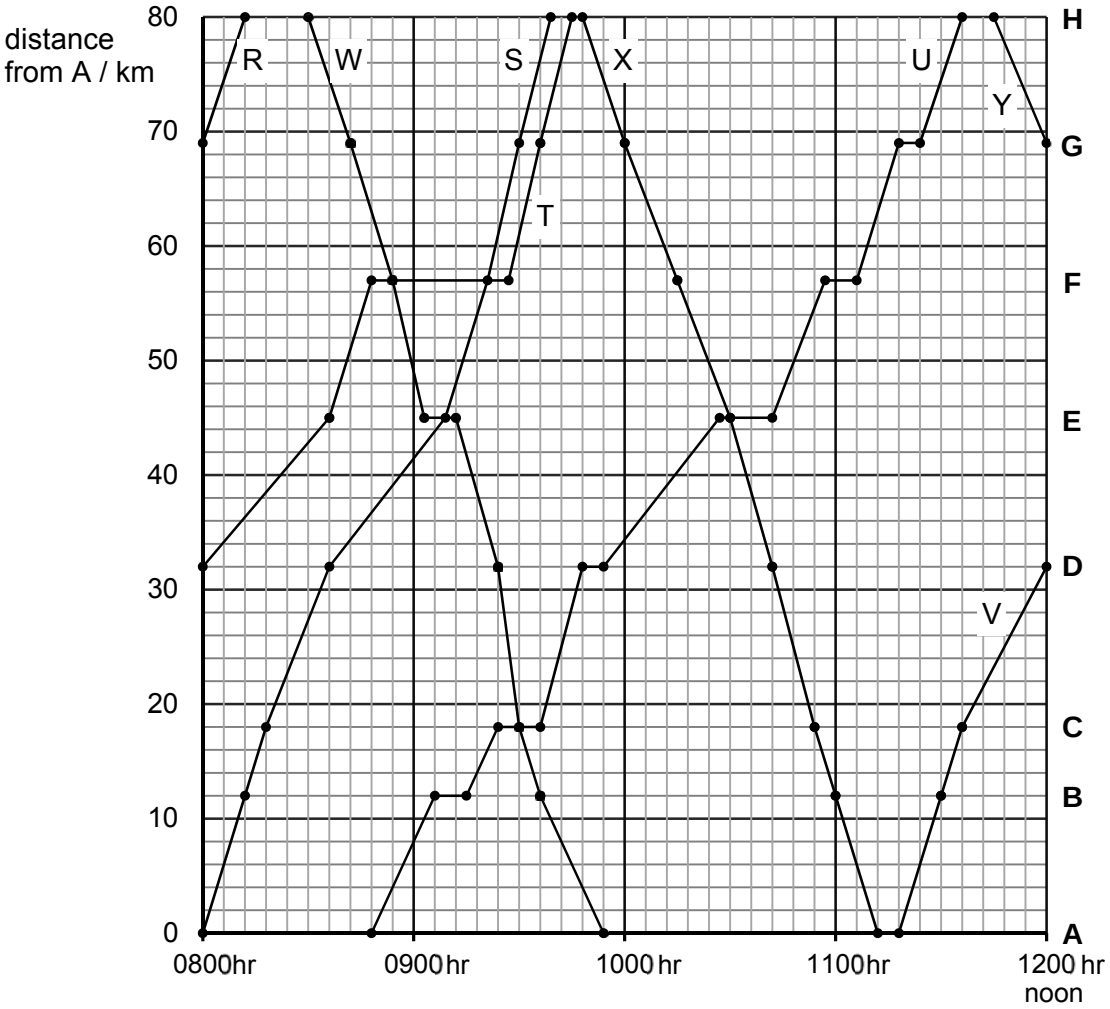


Fig. 6.1

(a) For complete journeys between A and H shown in Fig. 6.1, identify the trains which do not stop at intermediate stations.

..... [1]

(b) Use Fig. 6.1 to draw up a timetable for train W in Fig. 6.2.

Station	H	departure time	……..
Station	……	arrival time	……..
		departure time	……..
Station	A	arrival time	……..

Fig. 6.2

[2]

(c) (i) State the two stations between which train W is travelling at the maximum speed.

..... [1]

(ii) Calculate the maximum speed.

maximum speed = ... m s^{-1} [1]

(d) Suggest why all trains from D to E run slowly but trains from E to D run quickly.

.....

..... [1]

(e) Trains are travelling on a single track and can pass one another only in stations.

On Fig. 6.1, draw a possible line Z for an additional train running from A to H. [1]

Section B

Answer **two** of the questions in this Section.

7 **(a)** Distinguish between *gravitational potential energy* and *elastic potential energy*.

gravitational potential energy: ……

……

elastic potential energy: ……

…… [2]

(b) A light helical spring is suspended vertically from a fixed point, and a load of weight *W* is suspended from the spring, as shown in Fig. 7.1.

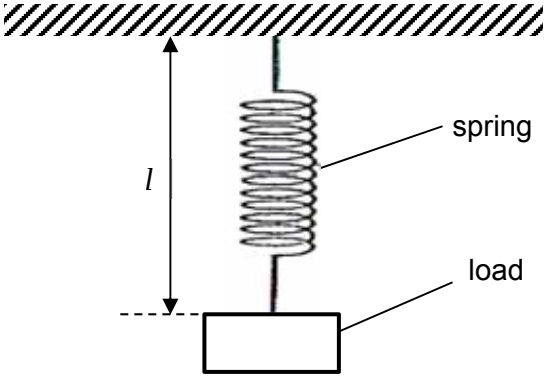


Fig. 7.1

The variation with weight *W* of the length *l* of the spring is shown in Fig. 7.2.

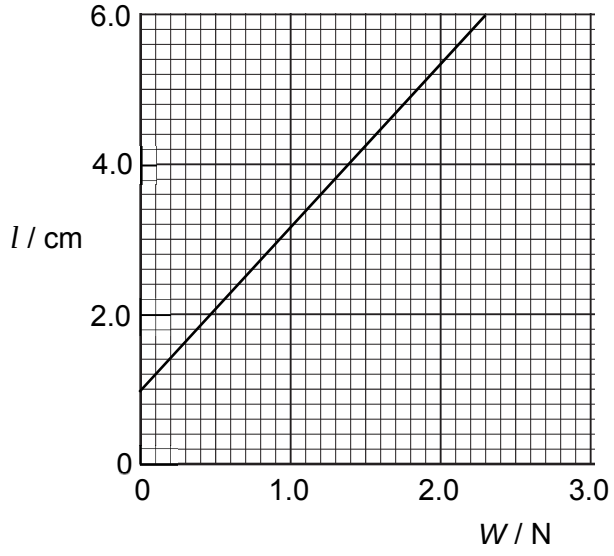


Fig. 7.2

(i) Calculate the spring constant of the spring.

spring constant = ... N m^{-1} [2]

(ii) A load of weight 2.3 N is suspended from the spring. It is raised 2.0 cm by hand and then held stationary.

For the decrease in length of 2.0 cm of the spring, determine the magnitude of the change in the

1. gravitational potential energy of the load,

change = ... J [2]

2. elastic potential energy of the spring.

change = ... J [2]

(iii) Explain why your answers in **(ii)** are not the same.

.....

..... [1]

(c) A cyclist travels up an inclined road that makes an angle of 7.8° with the horizontal as shown in Fig. 7.3. The cyclist and his bicycle have a total weight of 790 N. He takes 15 s to reach the top of the inclined road. The variation with time *t* of the speed *v* of the cyclist is shown in Fig. 7.4.

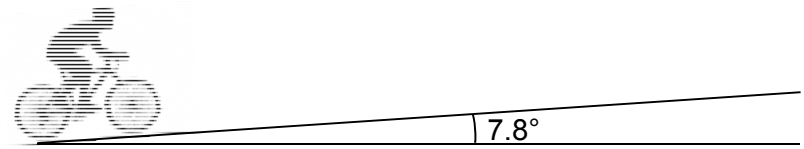


Fig. 7.3

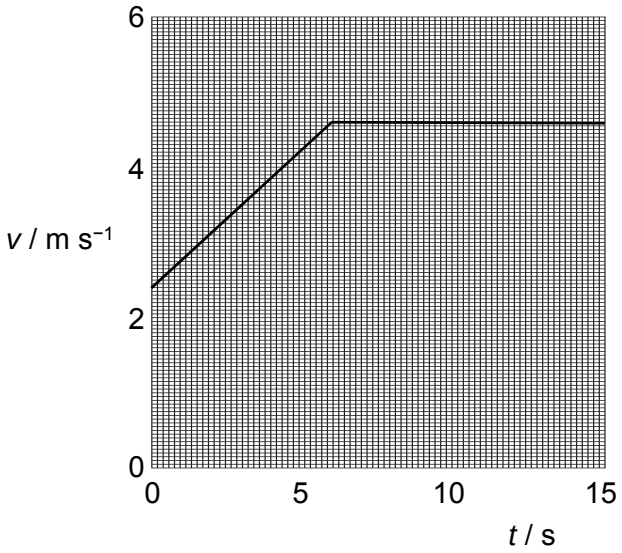


Fig. 7.4

(i) For the movement of the cyclist between $t = 0$ and $t = 6.0$ s,

1. calculate the change in kinetic energy,

change = ... J [2]

2. show that the vertical height through which the cyclist moves is 2.9 m,

[2]

3. calculate the change in gravitational potential energy,

change = ... J [1]

4. calculate the work done against the total resistive force, if the cyclist delivers a power of 550 W.

work done = ... J [2]

(ii) The total resistive force R on the cyclist can be given by the equation $R = 15 + 0.90v^2$ where v is the speed of the cyclist.

1. State the types of forces that contribute to the total resistive force R.

..... [1]

2. For the movement of the cyclist between t = 6.0 s and t = 15.0 s, calculate the power delivered by the cyclist.

power = ... W [3]

8 A battery of e.m.f. E and internal resistance of 3.0 Ω is connected to a variable resistor of resistance R, as shown in Fig. 8.1.

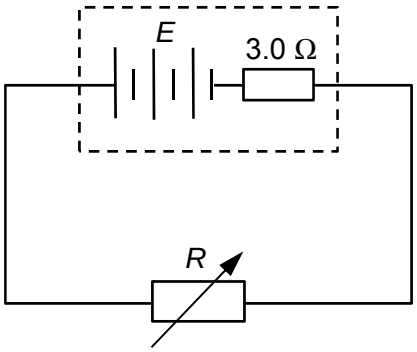


Fig. 8.1

The resistance R in the circuit is varied. The variation with R of the power P dissipated in the variable resistor is shown in Fig. 8.2.

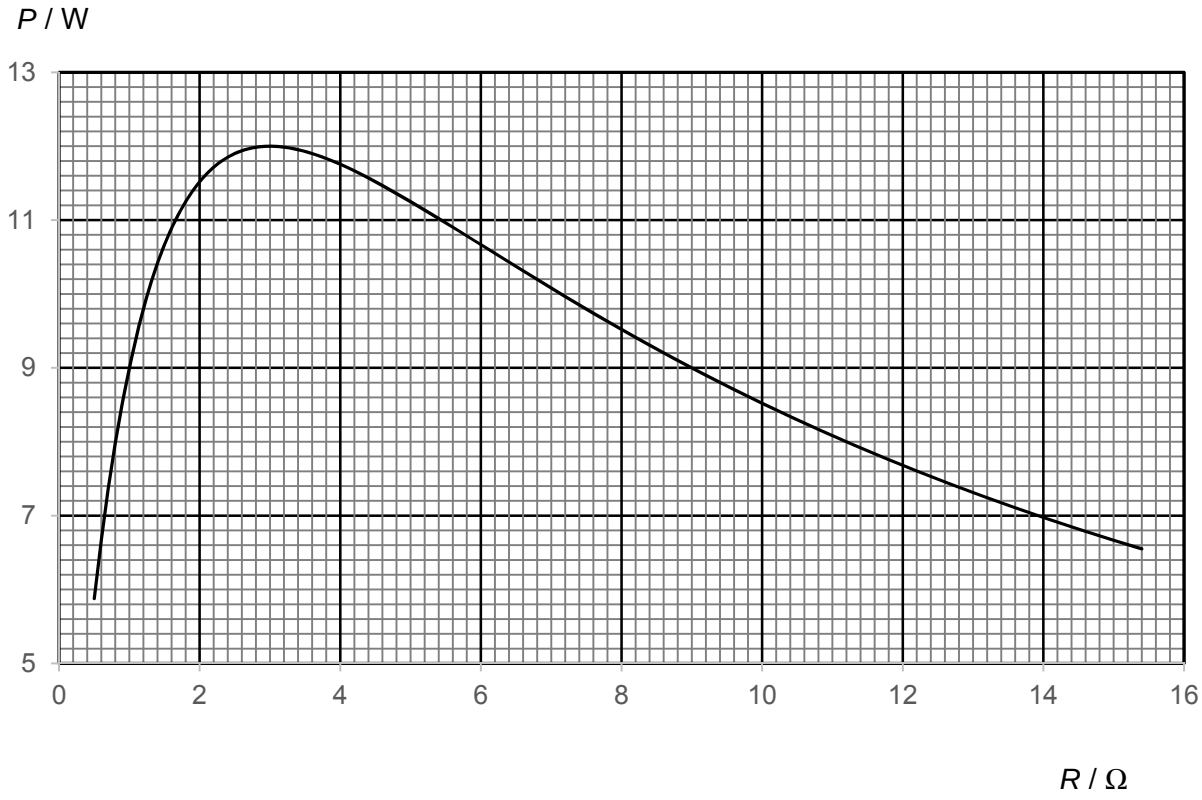


Fig. 8.2

(a) By reference to energy transfers, distinguish between e.m.f. and p.d.

……..

……..

……..

…… [2]

(b) When R = 14.0 Ω, calculate

(i) the current in the circuit,

current = ... A [2]

(ii) the e.m.f. E of the battery,

E = ... V [2]

(iii) the total energy supplied by the battery in 10 minutes.

energy = ... J [2]

(c) State the value of R at which the power dissipated in the variable resistor is a maximum.

R = ... Ω [1]

(d) With reference to Fig. 8.2, explain why the graph has a maximum value.

……..

……..

……..

…… [2]

(e) If the battery has negligible internal resistance, sketch the variation with *R* of the power *P* dissipated in the variable resistor on Fig. 8.3.

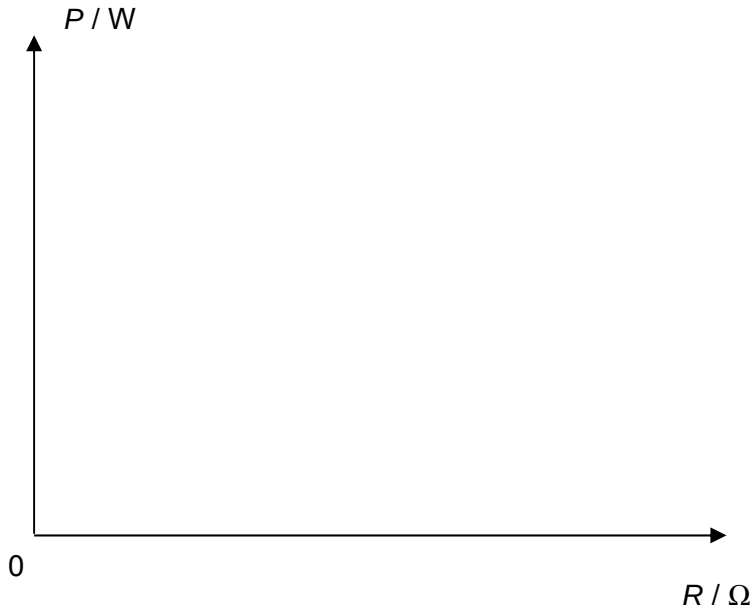


Fig. 8.3

[1]

(f) The battery is now connected to a wire frame ABCD supported on two pivots P and Q so that the section PBCQ of the frame lies within a solenoid, as shown in Fig. 8.4. The length of BC is 8.0 cm and the length of PB and QC is 20 cm. When there is no current in the circuit, the frame is horizontal.

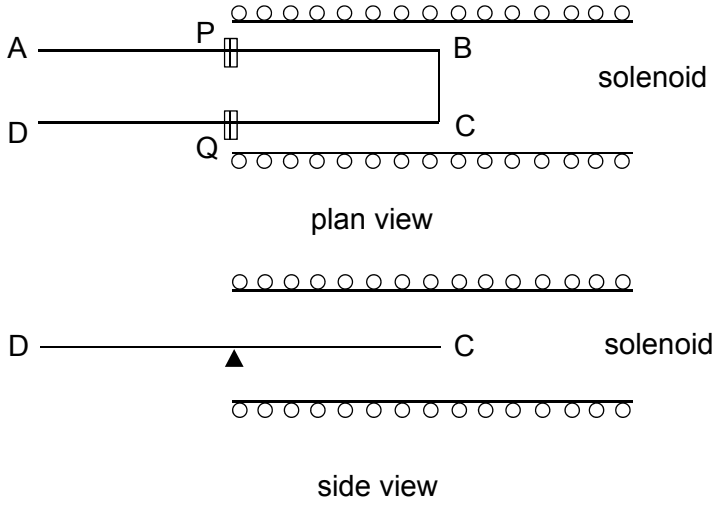


Fig. 8.4

When a current passes through the frame from A to D, a rider of mass 3.0 g is hung on side DQ at a position of 4.8 cm from Q in order to keep the frame horizontal.

(i) State and explain the direction of the magnetic field in the region of the solenoid.

……

……

……

……

……

…… [3]

(ii) Given that the resistance of the frame is 3.0 Ω, calculate the magnitude of the magnetic flux density in the region of the solenoid.

magnetic flux density = ... T [3]

(iii) Describe and explain what would be observed for the frame if it is shifted to the left such that BC is near the edge of the solenoid.

……

……

……

…… [2]

9 **(a)** A strip of clean magnesium ribbon is surrounded by a cylinder of copper gauze, as shown in Fig. 9.1. The copper gauze is maintained at a positive potential of 6.00 V with respect to the magnesium and the metals are connected to an ammeter and resistor R. The work function of magnesium is 2.80 eV and the work function of copper is 5.05 eV.

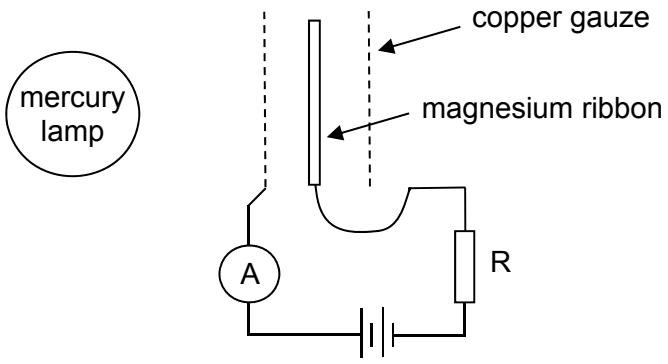


Fig. 9.1

When the magnesium ribbon is illuminated with light of wavelength 254 nm emitted from the mercury lamp, the ammeter detects a current flowing through R.

(i) State the origin of this current.

.....

..... [1]

(ii) Calculate the energy of a photon of light of wavelength 254 nm.

energy = ... J [1]

(iii) State and explain what would be observed in the ammeter when each of the following experiments is carried out separately.

1. The mercury lamp is moved further away from the magnesium ribbon.

.....

.....

..... [2]

2. The mercury lamp is replaced by another lamp which emits light of wavelength 546 nm.

.....

.....

..... [2]

3. The polarity of the 6.00 V battery is reversed.

.....

.....

..... [2]

4. The 6.00 V battery is replaced by a 10.0 V battery of the same polarity.

.....

.....

..... [2]

(b) Hydrogen gases can be placed inside a narrow discharge tube at low pressure, as shown in Fig. 9.2. When high voltage is applied across electrodes A and B, the discharge tube lights up (glow). When the light from the hydrogen gas is examined using a diffraction grating, an emission spectrum line is seen.

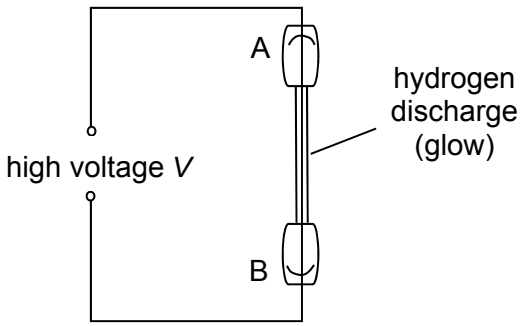


Fig. 9.2

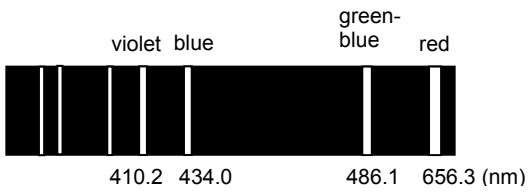


Fig. 9.3

(i) Explain why the discharge lamp lights up when high voltage is applied across it.

.....

.....

.....

..... [3]

(ii) Explain how the emission spectrum lines provide evidence for discrete energy levels in atom.

.....

.....

.....

..... [3]

(iii) Fig. 9.4 shows the lowest electron energy level of a hydrogen atom that gives rise to the Balmer series.

By using the values given in Fig. 9.3, complete the partial electron energy level diagram in Fig. 9.4. Show your calculations clearly.

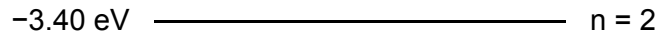


Fig. 9.4

[4]

End of paper

PJC Answers to JC2 Preliminary Examination Paper 2 (H1 Physics)

Suggested Solutions:

No.	Solution	Remarks
1(a)(i)	$v^2 = u^2 + 2as$ $= 2as$ $= 2(9.81)(2.0)$ $= 39.24 \text{ m}^2 \text{ s}^{-2}$ $v = 6.3 \text{ m s}^{-1}$	[1] for correct substitution [1] for correct answer
1(a)(ii)1.	$p_{\text{final}} = 0.050(0.70)(6.264)$ $= 0.22 \text{ kg ms}^{-1}$	[1] for substitution [1] for answer
1(a)(ii)2.	Take upwards as positive $\lvert\text{average resultant force}\rvert = \frac{\lvert\Delta p\rvert}{\Delta t}$ $= \frac{0.050(0.70)(6.264) - \left[-(0.05)6.264\right]}{0.1}$ $= 5.3246 \text{ N}$ $N - mg = 5.3246$ $N = 5.3246 + 0.05(9.81)$ $= 5.82 \text{ N}$	[1] for correct resultant force [1] for correct contact force
1(b)(i)	Take upwards as positive. $s_y = u_y t + \frac{1}{2} a_y t^2$ $9.0 = (17 \sin 60°)t + \frac{1}{2}(-9.81)t^2$ $t = 0.855 \text{ s}$ (rejected) or $t = 2.1468 \text{ s}$ $= 2.1 \text{ s}$ (2 s.f.)	[1] for correct substitution [1] for correct answer
1(b)(ii)	$s_x = u_x t$ $x = (17 \cos 60°)(2.1468)$ $= 18.248 \text{ m}$ $= 18 \text{ m}$	[1] for correct substitution and answer
2(a)(i)	The centre of gravity of a body is the single point at which the entire weight of the body can be considered to act.	[1]
2(a)(ii)	The torque of a couple is the turning effect of the couple, equal to the product of either force and the perpendicular distance between their lines of action.	[1]

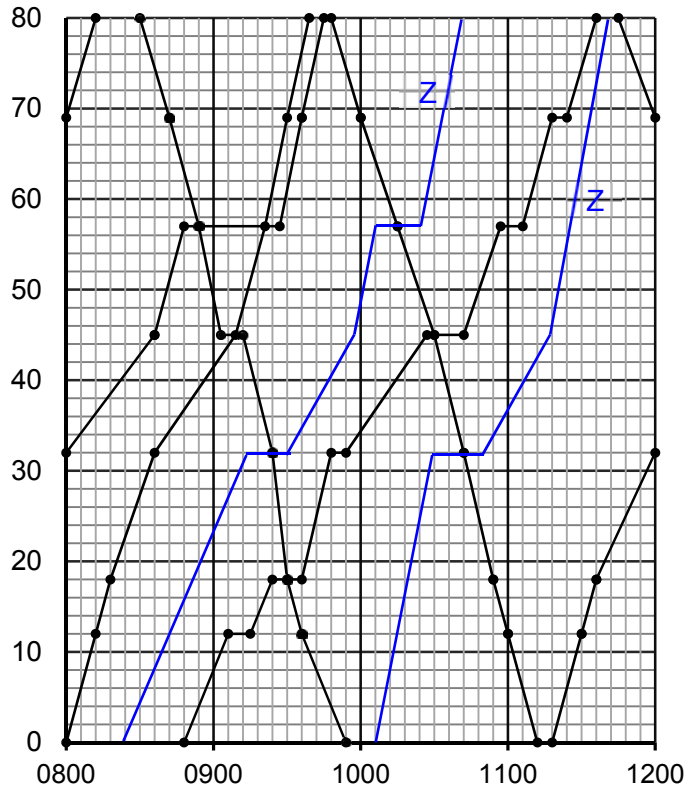
No.	Solution	Remarks
2(b)(i)	$T(2.8) = (600)(1.4\sin 50°) + (4000)(2.8\sin 50°)$ $T = 3294$ N $T \approx 3300$ N	[1] for correct substitution [1] for correct answer
2(b)(ii)	The force acting on the beam at Q has a leftward component. The other forces acting on the beam have no horizontal component. Therefore, a force at P that has a rightward component is required, in order to keep the beam in equilibrium.	[1] [1]
3(a)	Light waves are transverse waves	[1]
3(b)	Let amplitude of light that emerges from R be A_R. $A_R = A\cos(30°)\cos(45° - 30°)$ $= 0.84A$	[1] for correct substitution [1] for correct answer
3(c)	Let intensity of light that emerges from R be I_R. $I = kA^2$ $I_R = kA_R^2$ $= k(0.8365A)^2$ $= 0.70kA^2$ $= 0.70I$	[1] for correct substitution [1] for correct answer
4(a)	$\Delta x = \frac{\lambda D}{a}$ $1.7\times10^{-2} = \frac{\lambda(1.2)}{(0.030\times10^{-3})}$ $\lambda = 4.25\times10^{-7}$ m	[1] for correct substitution (conversion) [1] correct answer
4(b)(i)	The <u>fringe separation will</u> <u>increase</u> (by a factor of two), and the brightness will decrease, <u>contrast will decrease</u>.	[1] for fringe separation [1] for constrast
4(b)(ii)	In comparison, red light as a longer wavelength, therefore the <u>fringe separation will increase</u>, but there will be no change in brightness, hence <u>contrast remains the same</u>.	[1] for fringe separation [1] for constrast
4(b)(iii)	The light source is initially unpolarised. With the polariser, the light that passes through will be polarised in a single plane, hence the brightness of the fringe will be lower hence <u>contrast will decrease</u>, no change in fringe separation.	[1] for fringe separation [1] for contrast

<table>
<tr><th>No.</th><th>Solution</th><th>Remarks</th></tr>
<tr><td>5(a)</td><td>V_1 measures the terminal p.d. of the cell. It takes into account the potential drop across the internal resistance of the cell. Hence, V_1 is lower than the e.m.f. of the cell ($V = E - Ir$).</td><td>[1]</td></tr>
<tr><td>5(b)</td><td>In the dark, resistance of LDR = 800 Ω
$\text{voltmeter reading} = \left(\frac{800}{800+200+0.50}\right)10 = 8.0\ \text{V}$</td><td>[1] Correct equation and substitution</td></tr>
<tr><td>5(c)</td><td>In daylight, resistance of LDR = 160 Ω
Let R_1 be the effective resistance across the 200 Ω resistor and R.
$\left(\frac{160}{R_1+160+0.50}\right)10 = 8.0\ \text{V}$
$R_1 = 39.5\Omega$
$R_1 = \left(\frac{1}{R}+\frac{1}{200}\right)^{-1}$
$39.5 = \left(\frac{1}{R}+\frac{1}{200}\right)^{-1}$
R = 49.2 Ω</td><td>[1] For correct R_1
[1] Correct substitution
[1] Correct final answer</td></tr>
<tr><td>6(a)</td><td>Trains S and X</td><td>[1] for correct answer</td></tr>
<tr><td>6(b)</td><td><table><tr><td>Station</td><td>H</td><td>departure time</td><td>0830 h</td></tr><tr><td>Station</td><td>E</td><td>arrival time</td><td>0903 h</td></tr><tr><td></td><td></td><td>departure time</td><td>0912 h</td></tr><tr><td>Station</td><td>A</td><td>arrival time</td><td>0954 h</td></tr></table></td><td>[1] for any 3 correct answers

[2] for all correct answers</td></tr>
<tr><td>6(c)(i)</td><td>Stations D and C</td><td>[1] for correct answer</td></tr>
<tr><td>6(c)(ii)</td><td>Distance between stations D and C
= 14 km
= 14000 m

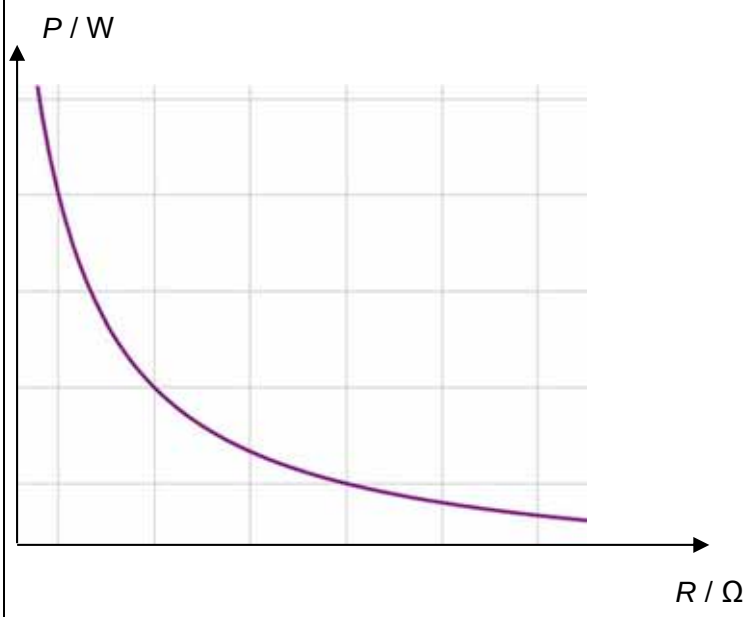
Time taken
= 6 min
= 360 s

Speed
$= \frac{\text{distance}}{\text{time}}$
$= \frac{14000}{360}$
$= 38.9$
$\approx 39\ \text{m s}^{-1}$</td><td>[1] for correct final answer</td></tr>
</table>

No.	Solution	Remarks
6(d)	The terrain gradient between stations D and E could be steep. Hence, trains travelling upslope from station D and station E go slower than those travelling downslope from station E to station D.	[1] for correct answer Accept any other logical reasoning
6(e)		[1] for correct answer Accept any possible lines Z
7(a)	Gravitational potential energy - Energy possessed by a mass due to its position in a gravitational field Elastic potential energy - Energy stored as a result of deformation of a solid	[1] [1]
7(b)(i)	$k = \frac{F}{x} = \frac{2.3}{(6.0-1.0)\times 10^{-2}} = 46 \text{ N m}^{-1}$	[1] for correct substitution [1] for correct answer

No.	Solution	Remarks
7(b)(ii)1.	Magnitude of change in GPE $= (2.3)(2.0 \times 10^{-2})$ $= 0.046 \text{ J}$	[1] for correct substitution [1] for correct answer
7(b)(ii)2.	Magnitude of change in EPE $= \frac{1}{2}(1.4 + 2.3)(2.0 \times 10^{-2})$ $= 0.037 \text{ J}$ OR Magnitude of change in EPE $= \frac{1}{2}(46)(5.0 \times 10^{-2})^2 - \frac{1}{2}(46)(3.0 \times 10^{-2})^2$ $= 0.0368 \text{ J}$ $\approx 0.037 \text{ J}$	[1] for correct substitution [1] for correct answer
7(b)(iii)	There is work done by hand to increase the total energy of the system of load and spring.	[1]
7(c)(i)1.	Change in KE $= \frac{1}{2}\left(\frac{790}{9.81}\right)\left(4.6^2 - 2.4^2\right)$ $= 620.1 \text{ J}$ $\approx 620 \text{ J}$	[1] for correct substitution [1] for correct answer
7(c)(i)2.	Distance travelled up inclined road $= \frac{1}{2}(2.4 + 4.6)(6.00)$ $= 21 \text{ m}$ Vertical height $= 21 \sin 7.8°$ $= 2.85 \text{ m}$ $\approx 2.9 \text{ m}$	[1] for correct substitution [1] for correct substitution
7(c)(i)3.	Change in GPE $= 790(2.850)$ $= 2252 \text{ J}$ $\approx 2300 \text{ J}$	[1] for correct substitution and for correct answer
7(c)(i)4.	Work done by cyclist = Gain in KE + Gain in EPE + Work done against resistive forces $(550)(6.00) = 620.1 + 2252 + \text{Work done against resistive force}$	[1] for correct substitution [1] for correct answer

No.	Solution	Remarks
	Work done against resistive force $= 427.9\ \text{J} \approx 430\ \text{J}$	
7(c)(ii)1.	Friction and viscous force / drag force / air resistance	[1]
7(c)(ii)2.	$P = Fv$ $P = (W \sin\theta + R)v$ $P = [790 \sin 7.8° + 15 + (0.90)(4.6^2)](4.6)$ $P = 649.8\ \text{W}$ $P \approx 650\ \text{W}$	[1] for correct R [1] for correct $W \sin\theta$ [1] for correct answer
8(a)	The e.m.f. of a source is the amount of energy converted into electrical energy from other forms of energy when a unit charge passes through it. The p.d. between two points in a circuit is the amount of electrical energy converted into other forms of energy when a unit charge flows through the two points.	[1] for correct description of e.m.f. [1] for correct description of p.d.
8(b)(i)	$P = I^2R$ $7.0 = I^2(14.0)$ $I = 0.71\ \text{A}$	[1] for correct use of equation [1] for correct answer
8(b)(ii)	$E = I(R + r)$ $= 0.71(14.0 + 3.0)$ $= 12.1\ \text{V}$	[1] for correct use of equation [1] for correct answer
8(b)(iii)	$Q = IEt$ $= (0.71)(12.1)(60 \times 10)$ $= 5150\ \text{J}$	[1] for correct use of equation [1] for correct answer
8(c)	$R = 3.0\ \Omega$	[1] for correct answer
8(d)	When R is smaller than r, a higher percentage of the power supplied by the battery is dissipated in the internal resistance. As R increases, the power dissipated in the variable resistor increases. However, the current decreases and this results in decreasing power dissipated in the variable resistor when R exceeds the value of r.	[1] for explanation of power dissipated when R is lower than r [1] for explanation of power dissipated when R is higher than r

No.	Solution	Remarks
8(e)	When $r = 0,\ P = \dfrac{V^2}{R}$  	[1] for correct shape of graph
8(f)(i)	The magnetic field is directed towards the left. A magnetic force must be acting downwards on BC which causes a clockwise moment about the pivots therefore the rider is placed to provide a counter moment to keep the frame horizontal. Hence, using Fleming's left hand rule, with the current flowing from B to C and force downwards, the magnetic field is directed towards the left.	[1] for correct direction of B field [1] for correct explanation of magnetic force [1] for applying Fleming's left hand rule
8(f)(ii)	$I = \dfrac{12.1}{3.0 + 3.0} = 2.02$ A By principle of moments, $F(0.20) = (3.0 \times 10^{-3})(9.81)(0.048)$ $F = 7.06 \times 10^{-3}$ N $F = BIL$ $7.06 \times 10^{-3} = B(2.02)(0.080)$ $B = 0.0437$ T	[1] for calculation of current [1] for applying principle of moments [1] for correct calculation of B
8(f)(iii)	The magnetic flux density near the edge of the solenoid is lower hence the magnetic force acting on BC is smaller. This will result in a net anticlockwise moment and the side BC of the frame will tilt upwards.	[1] for correct observation [1] for correct explanation

No.	Solution	Remarks
9(a)(i)	The current is due to the flow of photoelectrons, which are emitted from magnesium metal surface.	[1]
9(a)(ii)	$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{254\times10^{-9}} = 7.83\times10^{-19}\text{J}$	[1]
9(a)(iii) 1.	When the lamp is moved further away, the intensity of the light reaching the metal plate decreases. Since intensity is inversely proportional to the square of the distance apart. The number of photons per unit time reaching the plate decreases. Hence the number of photoelectrons emitted per unit time decreases. The current reading in the ammeter decreases.	[1] intensity related to no. of photons per unit time. [1] Current reading decreases
9(a)(iii) 2.	$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{546\times10^{-9}} = 2.27 \text{ eV}$ Photon of wavelength 546 nm has energy 2.27 eV. The photon energy is less than the work function of magnesium. Hence, there is no emission of photoelectrons. The ammeter reads zero value.	[1] less than work function of magnesium [1] Meter reads zero value (with correct explanation)
9(a)(iii) 3.	$hf = \Phi + eV_s$ $V_s = \frac{hf - \Phi}{e} = 4.89 - 2.80 = 2.09\text{V}$ When the battery is reversed, a 6.0 V reverse potential difference is applied across the plates. A reverse potential difference of 2.09 V would stop all photoelectrons. Hence, no photoelectrons reach the copper. The ammeter reads zero value.	[1] 6.0 V reverse potential difference is more than the stopping potential [1] Meter reads zero value (with correct explanation)
9(a)(iii) 4.	The ammeter reading remains unchanged. Even at a lower voltage of 6.00 V, all photoelectrons are absorbed by the copper gauze (saturation current reached). Therefore, the current in the circuit is only affected by the intensity of the light reaching the plates and not potential difference between the plate and gauze, for photons of fixed wavelength. Hence the current remains unchanged.	[2] Meter reading unchanged(with correct explanation)
9(b)(i)	Hydrogen gaseous atoms are excited through collisions with electrons from electrical discharge through the gas. The electrical discharge occurs due to the high potential difference between A and B. The electrons are excited to higher energy levels, which are unstable. The electrons transits to lower levels and energy is	[1] [1] [1]

No.	Solution	Remarks
	given off in the form of electromagnetic radiation, as photons. The discharge lamp lights up due to the emission of photons. Note: The energy of the emitted photon is equal to the difference between the energy levels.	
9(b)(ii)	Only specific frequencies of light produce lines in the emission spectrum of isolated atoms. Since light consists of photons, this means that only specific energies are emitted by the atoms, which suggests that there are fixed energy transitions between discrete energy levels responsible for the production of such photons.	[1] [1] [1]
9(b)(iii)	−0.37 eV ——— n = 6 −0.54 eV ——— n = 5 −0.84 eV ——— n = 4 −1.51 eV ——— n = 3 −3.40 eV ——— n = 2 Workings: For 656.3 nm, $\Delta E_1 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{656.3\times10^{-9}} = 1.89 \text{ eV}$ For 486.1 nm, $\Delta E_2 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{486.1\times10^{-9}} = 2.56 \text{ eV}$ For 434.0 nm, $\Delta E_3 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{434\times10^{-9}} = 2.86 \text{ eV}$ For 410.2 nm, $\Delta E_4 = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}(3\times10^{8})}{410.2\times10^{-9}} = 3.03 \text{ eV}$	[1] 5 energy levels of decreasing energy gap as energy increases. [1] Correct substitution into $E = \frac{hc}{\lambda}$ [2] Correct energy levels values