

Candidate Name	Centre Number	Candidate Number
		2



GCE AS/A level

1321/01

PHYSICS

PH1: MOTION ENERGY AND CHARGE

P.M. THURSDAY, 27 May 2010

1½ hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80.

The number of marks is given in brackets at the end of each question or part question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	7	
2.	9	
3.	6	
4.	12	
5.	9	
6.	12	
7.	16	
8.	9	
Total	80	

1. (a) (i) State the difference between vector and scalar quantities.

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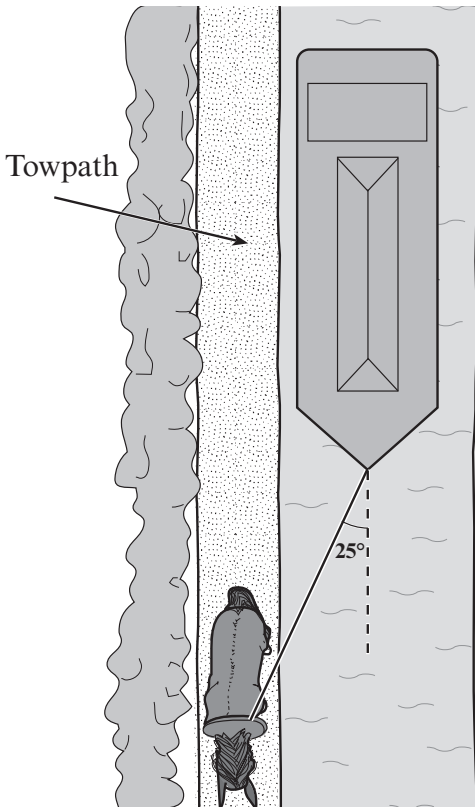
[1]

(ii) Place the following quantities in the correct column in the table below. [2]

distance time velocity temperature force density

Vector	Scalar

(b) A boat is pulled along a canal by a horse using a rope tied to the boat's bow. The rope makes an angle of 25° with the centre line of the canal as shown.



(i) Calculate the forward component of the force pulling the boat along the canal given that the tension in the rope is 1600 N. [2]

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(ii) Ignoring the effect of the mass of the rope, explain whether it is better to use a long rope or a short rope to pull the boat. [2]

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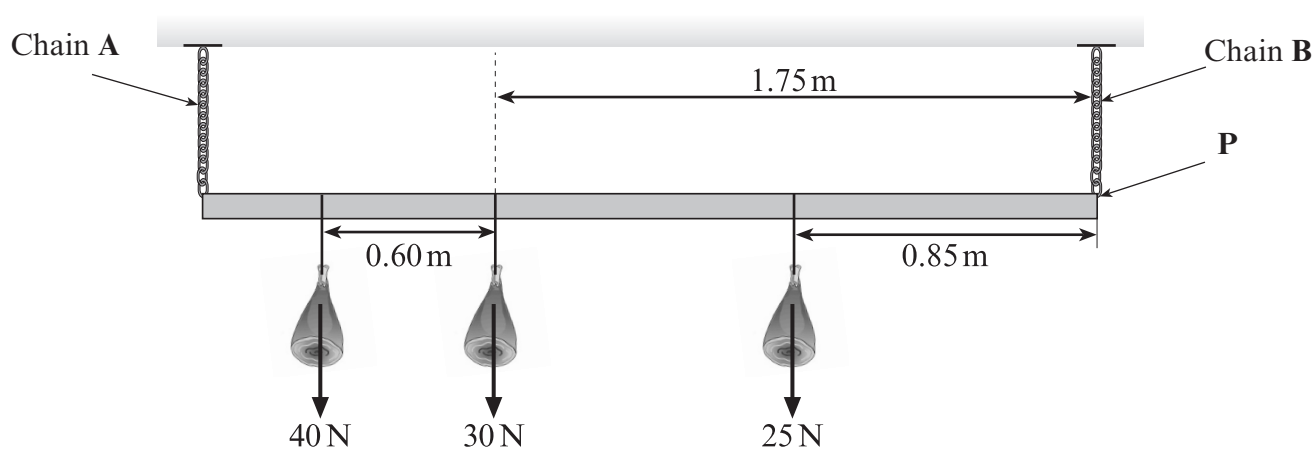
2. (a) State the conditions necessary for a body to remain in equilibrium. [2]

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- (b) The owner of a high-street butcher shop hangs joints of meat from a uniform metal bar as shown. The bar is 3.0 m long, weighs 20 N and is connected to the shop's ceiling by two light chains, **A** and **B**.



- (i) On the diagram, show the weight of the bar as an arrow acting through the centre of gravity and label it 20 N. [1]
- (ii) Taking moments about point **P**, calculate the tension in chain **A**. [4]

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- (iii) Hence calculate the tension in chain **B**. [2]

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3. (a) What is a *superconductor*?

[1]

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(b) With the aid of a sketch graph, explain the term *superconducting transition temperature*. [3]

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(c) Explain why superconductors are useful for applications which require large electric currents and name **one** such application. [2]

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4. A student measures the potential difference across a metal wire for a range of current values.

(a) Draw a diagram of a circuit which could be used.

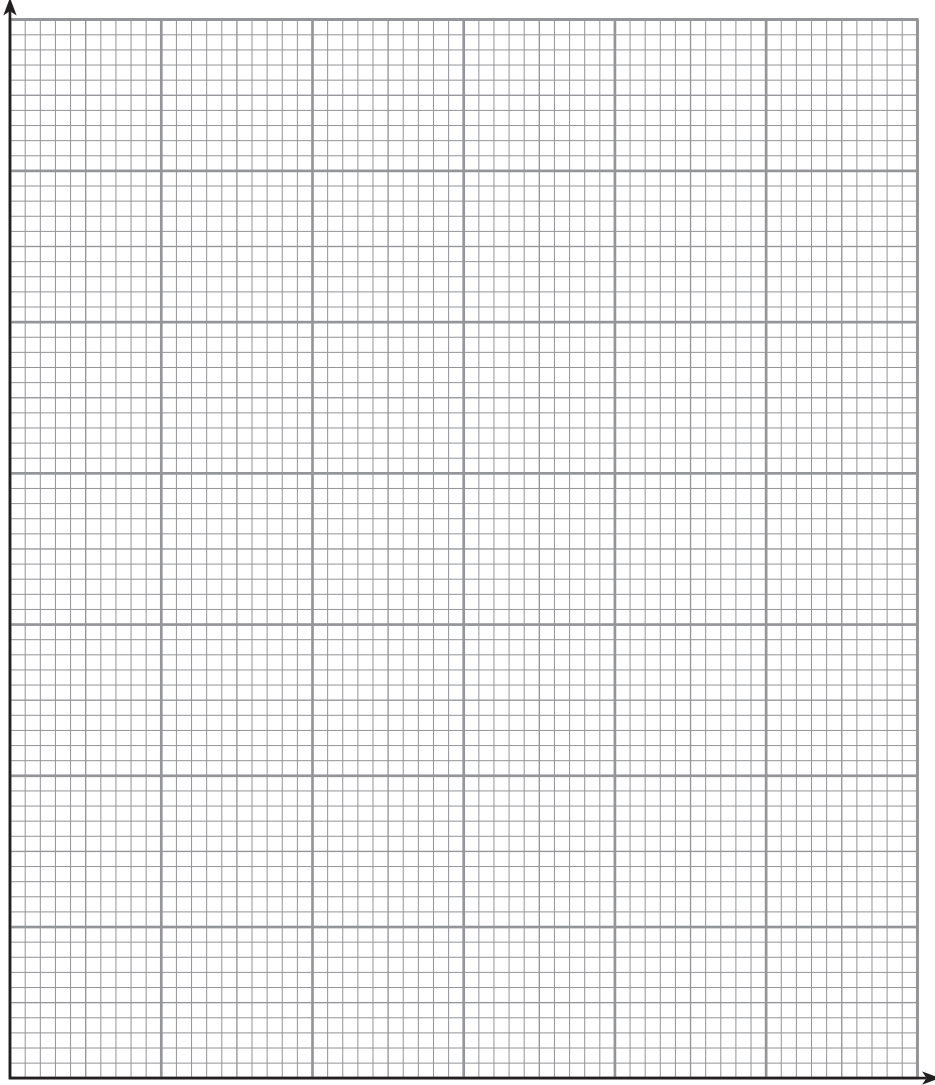
[2]

(b) (i) The table below shows the results obtained. Complete the column labelled 'Resistance'. [1]

Current/A	p.d./V	Resistance/ Ω
0.10	0.40	
0.20	0.80	
0.30	1.30	
0.40	1.90	
0.50	3.00	

- (ii) Draw a graph of **resistance** (y -axis) against **current** (x -axis).

[3]



- (c) (i) Describe how the resistance of the wire varies with current. [2]

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- (ii) Give the range of currents over which Ohm's law applies to the wire. [1]

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- (iii) Explain why Ohm's law does not apply outside this range. [1]

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- (d) In an electric fire current flows through a wire called an element. An ammeter is placed in series with the element. Predict what would happen to the ammeter reading from the time the fire is switched on until it reaches a steady operating temperature. [2]

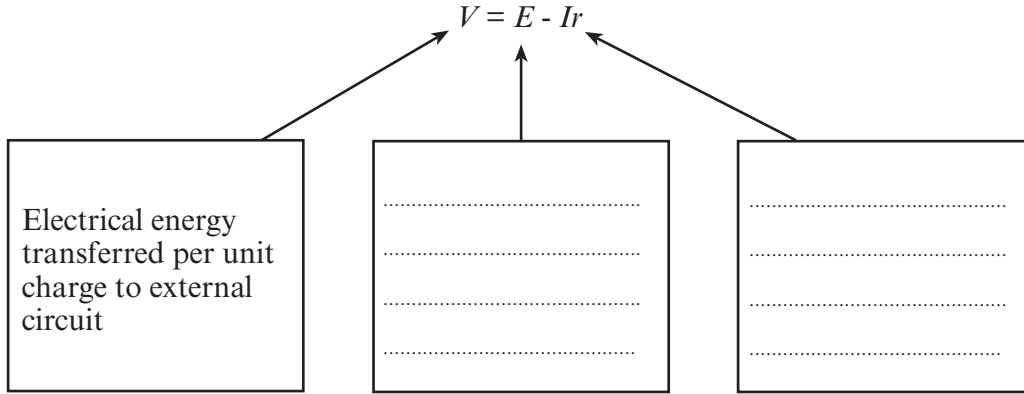
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5. (a) An equation which can be applied to a circuit containing a cell of e.m.f. E and internal resistance r is shown. Fill in the boxes to explain each quantity in **terms of energy**. The first has been completed as an example. [3]



- (b) A torch battery transfers 4750 J of chemical energy into electrical energy while supplying a current of 0.22 A for 1 hour (3600 s) and delivering 4500 J of energy to the bulb. Calculate

(i) the charge that flows; [1]

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(ii) the e.m.f. of the battery; [1]

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(iii) the p.d. across the bulb; [1]

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(iv) the p.d. across the internal resistance (the 'lost volts'); [1]

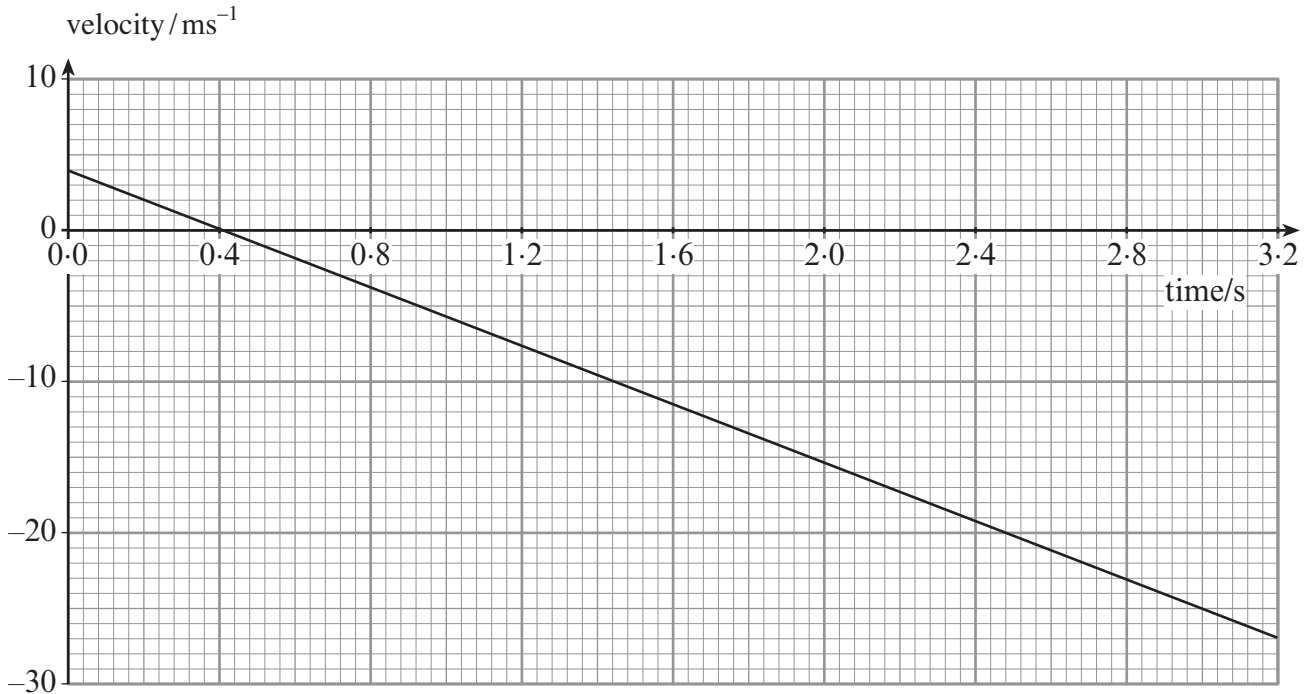
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(v) the battery's internal resistance. [2]

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6. A stone is released from the basket of a hot-air balloon that is moving upwards. The velocity-time graph describes the vertical motion of the stone from the moment it is released to the time it lands on the ground at 3.2 s. Ignore air resistance throughout this question.



- (a) Calculate the gradient of the graph and explain its significance. [2]

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- (b) State the velocity at which the balloon was ascending at the moment the stone was released. [1]

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- (c) Describe the motion of the stone between 0.0 s and 0.8 s. [3]

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(d) (i) Shade the part of the graph which represents the height of the stone above the ground at the moment of release. [1]

(ii) Hence, or otherwise, calculate the height of the stone above the ground at the moment of release. [2]

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(e) The balloon is also moving **horizontally** at a steady velocity when the stone is released. State whether the stone will land on the ground behind, directly beneath or in front of the moving basket. Explain your answer. [3]

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7. (a) (i) Define *work*.

[2]

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(ii) Hence express the unit of work, J, in terms of the SI base units kg, m and s.

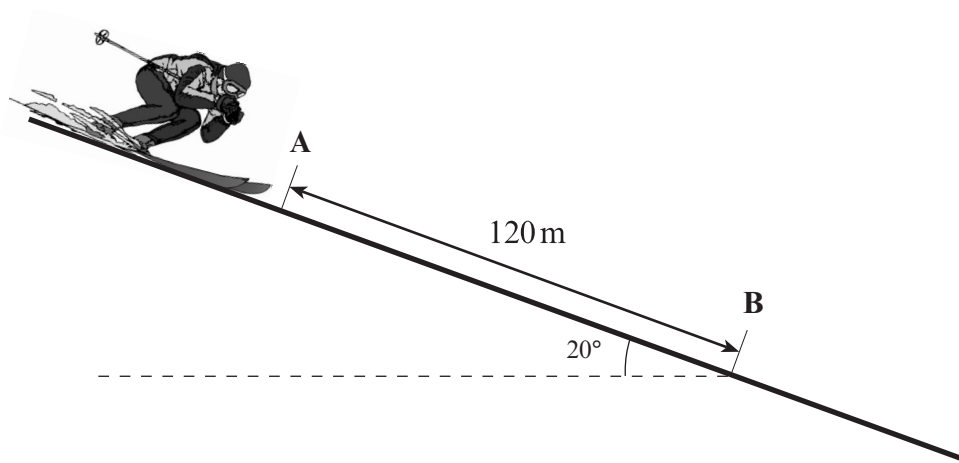
[2]

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(b)



A skier of mass 70 kg descends a slope inclined at 20° to the horizontal as shown. The skier passes point **A** at a speed of 6 ms^{-1} and a second point **B** at a speed of 21 ms^{-1} . The distance between **A** and **B** is 120 m. Calculate, for the descent from **A** to **B**,

(i) the gravitational potential energy lost by the skier;

[2]

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(ii) the kinetic energy gained by the skier.

[3]

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(c) (i) State the principle of conservation of energy. [1]

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(ii) Discuss your answers to (b) (i) and (ii) in terms of this principle. [2]

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(d) Calculate the mean resistive force experienced by the skier between **A** and **B**. [4]

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QUESTION 8 IS ON PAGE 14

8. (a) *Copper is an electrical conductor.* Explain what this statement means. [1]

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(b) (i) The density of copper is 8920 kgm^{-3} . Calculate the mass of a copper wire that has a cross-sectional area of $2.0 \times 10^{-6} \text{ m}^2$ and is 2.0 m long. [2]

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(ii) Determine the **total** number of free electrons in this wire given that an atom of copper has a mass of $1.05 \times 10^{-25} \text{ kg}$ and each atom contributes, on average, 1.5 electrons. [2]

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(iii) Calculate the mean drift velocity of the electrons in the wire when there is a current of 1.2 A. [4]

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GCE PHYSICS TAG FFISEG

Advanced Level / Safon Uwch

Data Booklet

A clean copy of this booklet should be issued to candidates for their use during each GCE Physics examination.

Centres are asked to issue this booklet to candidates at the start of the GCE Physics course to enable them to become familiar with its contents and layout.

Values and Conversions

Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
Fundamental electronic charge	$e = 1.60 \times 10^{-19} \text{ C}$
Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Molar gas constant	$R = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Acceleration due to gravity at sea level	$g = 9.81 \text{ m s}^{-2}$
Gravitational field strength at sea level	$g = 9.81 \text{ N kg}^{-1}$
Universal constant of gravitation	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
Speed of light <i>in vacuo</i>	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
Permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
Permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
Stefan constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$
Wien constant	$W = 2.90 \times 10^{-3} \text{ m K}$

$$T/\text{K} = \theta/^\circ\text{C} + 273.15$$

$$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$$

AS

$$\rho = \frac{m}{V}$$

$$v = u + at$$

$$x = \frac{1}{2}(u + v)t$$

$$x = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2ax$$

$$\Sigma F = ma$$

$$W = Fx \cos \theta$$

$$\Delta E = mg\Delta h$$

$$E = \frac{1}{2}kx^2$$

$$E = \frac{1}{2}mv^2$$

$$Fx = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$\text{Efficiency} = \frac{\text{Useful energy transfer}}{\text{total energy input}} \times 100\%$$

$$P = \frac{W}{t} = \frac{\Delta E}{t}$$

$$I = \frac{\Delta Q}{\Delta t}$$

$$I = nAve$$

$$R = \frac{\rho l}{A}$$

$$R = \frac{V}{I}$$

$$P = IV$$

$$V = E - Ir$$

$$\frac{V}{V_{\text{total}}} \left(\text{or } \frac{V_{\text{OUT}}}{V_{\text{IN}}} \right) = \frac{R}{R_{\text{total}}}$$

$$c = f\lambda$$

$$T = \frac{1}{f}$$

$$\lambda = \frac{ay}{D}$$

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

$$n_1 v_1 = n_2 v_2$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

$$E_{k \max} = hf - \phi$$

$$\lambda_{\max} = W T^{-1}$$

$$P = A\sigma T^4$$

Particle Physics

particle (symbol)	Leptons		Quarks	
	electron (e^-)	electron neutrino (ν_e)	up (u)	down (d)
charge (e)	-1	0	$+\frac{2}{3}$	$-\frac{1}{3}$
Lepton number	1	1	0	0

A2

$$\omega = \frac{\theta}{t}$$

$$v = \omega r$$

$$a = \omega^2 r$$

$$a = -\omega^2 x$$

$$x = A \sin(\omega t + \varepsilon)$$

$$v = A \omega \cos(\omega t + \varepsilon)$$

$$T = 2\pi \sqrt{\frac{m}{k}}$$

$$p = mv$$

$$Q = mc\Delta\theta$$

$$p = \frac{h}{\lambda}$$

$$\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

$$M/\text{kg} = \frac{M_r}{1000}$$

$$pV = nRT$$

$$p = \frac{1}{3} \rho c^2$$

$$U = \frac{3}{2} nRT$$

$$k = \frac{R}{N_A}$$

$$W = p\Delta V$$

$$\Delta U = Q - W$$

$$C = \frac{Q}{V}$$

$$C = \frac{\varepsilon_0 A}{d}$$

$$U = \frac{1}{2} QV$$

$$Q = Q_0 e^{-\lambda t}$$

$$F = BIl \sin \theta \text{ and } F = Bqv \sin \theta$$

$$B = \frac{\mu_0 I}{2\pi a}$$

$$B = \mu_0 nI$$

$$\Phi = AB \cos \theta$$

$$V_{\text{r.m.s.}} = \frac{V_0}{\sqrt{2}}$$

$$A = \lambda N$$

$$N = N_0 e^{-\lambda t} \text{ or } N = \frac{N_0}{2^x}$$

$$A = A_0 e^{-\lambda t} \text{ or } A = \frac{A_0}{2^x}$$

$$\lambda = \frac{\log_e 2}{T_{1/2}}$$

$$E = mc^2$$

Fields

$$F = \frac{1}{4\pi\varepsilon_0} \frac{Q_1 Q_2}{r^2}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$

$$V_E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r}$$

$$W = q\Delta V_E,$$

$$F = G \frac{M_1 M_2}{r^2}$$

$$g = \frac{GM}{r^2}$$

$$V_g = \frac{-GM}{r}$$

$$W = m\Delta V_g$$

Orbiting Bodies

$$\text{Centre of mass: } r_1 = \frac{M_2}{M_1 + M_2} d;$$

$$\text{Period of Mutual Orbit: } T = 2\pi \sqrt{\frac{d^3}{G(M_1 + M_2)}}$$

Options

$$\text{A: } \frac{V_1}{N_1} = \frac{V_2}{N_2}; \quad E = -L \frac{\Delta I}{\Delta t}; \quad X_L = \omega L; \quad X_C = \frac{1}{\omega C}; \quad Z = \sqrt{X^2 + R^2}; \quad Q = \frac{\omega_0 L}{R}$$

$$\text{B: } c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}; \quad \Delta t = \frac{\Delta \tau}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\text{C: } \varepsilon = \frac{\Delta I}{l}; \quad Y = \frac{\sigma}{\varepsilon}; \quad \sigma = \frac{F}{A}; \quad U = \frac{1}{2} \sigma \varepsilon V$$

$$\text{D: } I = I_0 \exp(-\mu x); \quad Z = c\rho$$

$$\text{E: } \frac{\Delta Q}{\Delta t} = -AK \frac{\Delta \theta}{\Delta x}; \quad U = \frac{K}{\Delta x}; \quad \frac{Q_2}{Q_1} = \frac{T_2}{T_1}; \quad \text{Carnot efficiency} = \frac{Q_1 - Q_2}{Q_1}$$

Mathematical Information

SI multipliers

Multiple	Prefix	Symbol
10^{-18}	atto	a
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n
10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c

Multiple	Prefix	Symbol
10^3	kilo	k
10^6	mega	M
10^9	giga	G
10^{12}	tera	T
10^{15}	peta	P
10^{18}	exa	E
10^{21}	zetta	Z

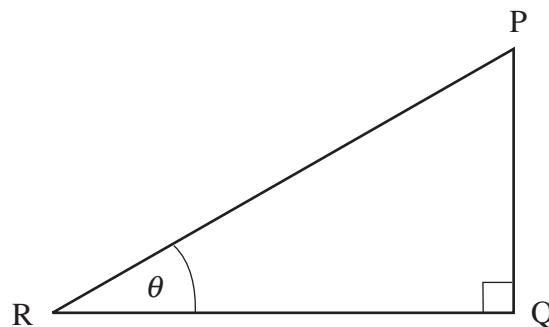
Areas and Volumes

$$\text{Area of a circle} = \pi r^2 = \frac{\pi d^2}{4}$$

$$\text{Area of a triangle} = \frac{1}{2} \text{ base} \times \text{height}$$

Solid	Surface area	Volume
rectangular block	$2(lh + hb + lb)$	lbh
cylinder	$2\pi r(r + h)$	$\pi r^2 h$
sphere	$4\pi r^2$	$\frac{4}{3}\pi r^3$

Trigonometry



$$\sin \theta = \frac{PQ}{PR}, \quad \cos \theta = \frac{QR}{PR}, \quad \tan \theta = \frac{PQ}{QR}, \quad \frac{\sin \theta}{\cos \theta} = \tan \theta$$

$$PR^2 = PQ^2 + QR^2$$

Logarithms (A2 only)

[Unless otherwise specified 'log' can be \log_e (i.e. \ln) or \log_{10} .]

$$\log(ab) = \log a + \log b$$

$$\log\left(\frac{a}{b}\right) = \log a - \log b$$

$$\log x^n = n \log x$$

$$\log_e e^{kx} = \ln e^{kx} = kx$$

$$\log_e 2 = \ln 2 = 0.693$$