A LEVEL Cambridge Topical Past Papers

PHYSICS

PAPER 2 2017 — 2023

Physics 9702

TOPICAL PAST PAPER WORKSHEETS

2017 - 2023 | Questions + Mark scheme

AVAILABLE PAPERS

P1
1734 Questions

P2
431 Questions

P4
376 Questions

www.exam-mate.com

TOPICS	P1	P2	P4
PHYSICAL QUANTITIES & UNITS	86	29	2
MEASUREMENT TECHNIQUES	81	18	0
KINEMATICS	132	43	0
DYNAMICS	170	46	2
FORCES, DENSITY & PRESSURE	153	32	1
WORK, ENERGY & POWER	163	38	0
MOTION IN CIRCLE	1	1	11
GRAVITATIONAL FIELDS	0	0	26
DEFORMATION OF SOLIDS	73	16	0
IDEAL GASES	5	1	25
TEMPERATURE	0	0	14
THERMAL PROPERTIES OF MATERIALS	1	0	19
OSCILLATIONS	3	0	26
WAVES	228	38	6
SUPERPOSITION	164	36	0
COMMUNICATION	1	0	25
ELECTRIC FIELDS	68	19	24
CAPACITANCE	0	0	16
CURRENT OF ELECTRICITY	179	44	3
D.C. CIRCUITS	115	29	2
ELECTRONICS	4	0	21
MAGNETIC FIELDS	0	0	34
ELECTROMAGNETIC INDUCTION	0	0	28
ALTERNATING CURRENTS	2	0	14
QUANTOM PHYSICS	2	0	34
PARTICLE & NUCLEAR PHYSICS	103	41	27
MEDICAL IMAGING	0	0	10
ASTRONOMY & COSMOLOGY	0	0	6

1 - (9702/21_Summer_2017_Q1) - *Physical Quantities & Units, Measurement Techniques*

(a) Determine the SI base units of stress.
Show your working.

base units ....[2]

(b) A beam PQ is clamped so that the beam is horizontal. A mass *M* of 500 g is hung from end Q and the beam bends slightly, as illustrated in Fig. 1.1.

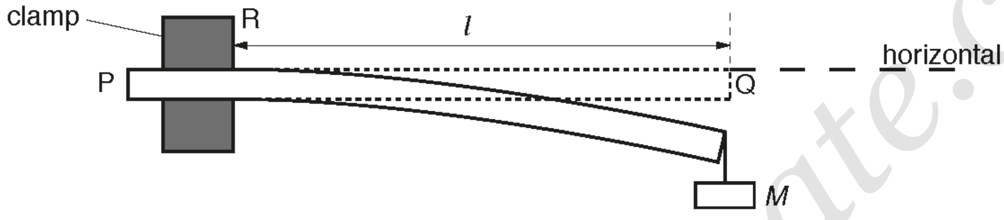

Fig. 1.1

The length *l* of the beam from the edge of the clamp R to end Q is 60.0 cm. The width *b* of the beam is 30.0 mm and the thickness *d* of the beam is 5.00 mm. The material of the beam has Young modulus *E*.

The mass *M* is made to oscillate vertically. The time period *T* of the oscillations is 0.58 s.

The period *T* is given by the expression

$$T = 2\pi\sqrt{\frac{4Ml^3}{Ebd^3}}.$$

(i) Determine *E* in GPa.

E = ...GPa [3]

(ii) The quantities used to determine *E* should be measured with accuracy and with precision.

1. Explain the difference between accuracy and precision.

accuracy: ....

....

precision: ....

....
[2]

2. In a particular experiment, the quantities *l* and *T* are measured with the same percentage uncertainty. State and explain which of these two quantities contributes more to the uncertainty in the value of *E*.

....

....

....[1]

2 - (9702/22_Summer_2017_Q1) - *Physical Quantities & Units, Measurement Techniques*

(a) State two SI base units other than kilogram, metre and second.

1. ....

2. ....
[1]

(b) Determine the SI base units of resistivity.

base units ....[3]

(c) **(i)** A wire of cross-sectional area 1.5 mm^2 and length 2.5 m has a resistance of 0.030 Ω. Calculate the resistivity of the material of the wire in nΩ m.

resistivity = ... nΩ m [3]

(ii) **1.** State what is meant by *precision*.

....

....

2. Explain why the precision in the value of the resistivity is improved by using a micrometer screw gauge rather than a metre rule to measure the diameter of the wire.

....

....

....

[2]

3 - (9702/23_Summer_2017_Q1) - *Physical Quantities & Units*

(a) Two forces, with magnitudes 5.0 N and 12 N, act from the same point on an object. Calculate the magnitude of the resultant force *R* for the forces acting

(i) in opposite directions,

R = ... N [1]

(ii) at right angles to each other.

R = ... N [1]

(b) An object X rests on a smooth horizontal surface. Two horizontal forces act on X as shown in Fig. 1.1.

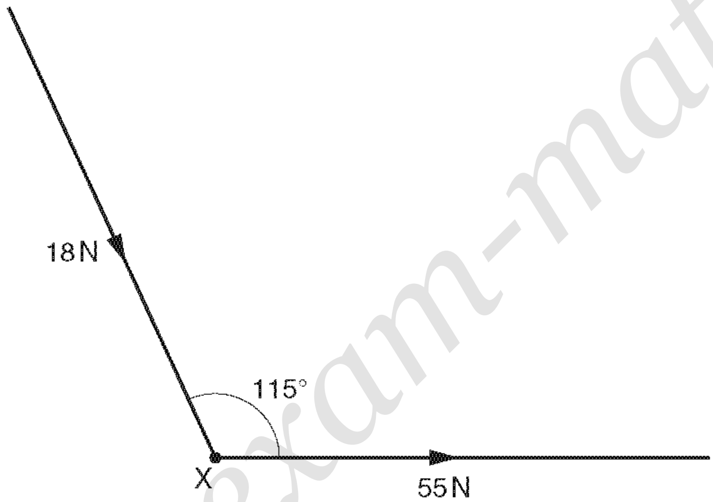

Fig. 1.1 (not to scale)

A force of 55 N is applied to the right. A force of 18 N is applied at an angle of 115° to the direction of the 55 N force.

(i) Use the resolution of forces or a scale diagram to show that the magnitude of the resultant force acting on X is 65 N.

[2]

(ii) Determine the angle between the resultant force and the 55 N force.

angle = ... ° [2]

(c) A third force of 80 N is now applied to X in the opposite direction to the resultant force in **(b)**.

The mass of X is 2.7 kg.

Calculate the magnitude of the acceleration of X.

acceleration = ... $m s^{-2}$ [3]

4 - (9702/21_Winter_2017_Q1) - *Physical Quantities & Units, Kinematics, Dynamics*

(a) The drag force F_D acting on a sphere moving through a fluid is given by the expression

$$F_D = K\rho v^2$$

where K is a constant,
ρ is the density of the fluid
and v is the speed of the sphere.

Determine the SI base units of K.

base units .... [3]

(b) A ball of weight 1.5 N falls vertically from rest in air. The drag force F_D acting on the ball is given by the expression in **(a)**. The ball reaches a constant (terminal) speed of 33 m s^{-1}.

Assume that the upthrust acting on the ball is negligible and that the density of the air is uniform.

For the instant when the ball is travelling at a speed of 25 m s^{-1}, determine

(i) the drag force F_D on the ball,

F_D = ... N [2]

(ii) the acceleration of the ball.

acceleration = ... m s^{-2} [2]

(c) Describe the acceleration of the ball in **(b)** as its speed changes from zero to 33 m s^{-1}.

....

....

....

....[3]

5 - (9702/23_Winter_2017_Q1) - *Physical Quantities & Units*

(a) **(i)** Define *power*.

....

....[1]

(ii) Show that the SI base units of power are $kg\,m^2\,s^{-3}$.

[1]

(b) All bodies radiate energy. The power P radiated by a body is given by

$$P = kAT^4$$

where T is the thermodynamic temperature of the body,
A is the surface area of the body
and k is a constant.

(i) Determine the SI base units of k.

base units ....[2]

(ii) On Fig. 1.1, sketch the variation with T^2 of P. The quantity A remains constant.

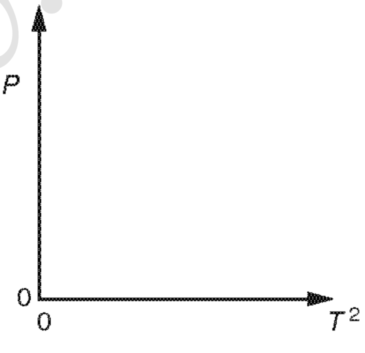

Fig. 1.1

[1]

6 - (9702/21_Summer_2018_Q1) - *Physical Quantities & Units, Kinematics*

(a) State what is meant by a *scalar* quantity and by a *vector* quantity.

scalar: ....

....

vector: ....

....
[2]

(b) Complete Fig. 1.1 to indicate whether each of the quantities is a vector or a scalar.

quantity	vector or scalar
power	
temperature	
momentum	

Fig. 1.1

[2]

(c) An aircraft is travelling in wind. Fig. 1.2 shows the velocities for the aircraft in still air and for the wind.

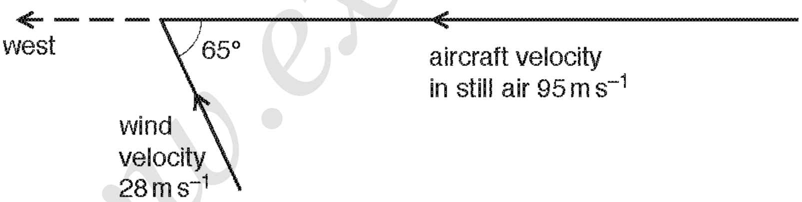

Fig. 1.2

The velocity of the aircraft in still air is $95\,m\,s^{-1}$ to the west.
The velocity of the wind is $28\,m\,s^{-1}$ from 65° south of east.

(i) On Fig. 1.2, draw an arrow, labelled R, in the direction of the resultant velocity of the aircraft. [1]

(ii) Determine the magnitude of the resultant velocity of the aircraft.

magnitude of velocity = ... ms^{-1} [2]

ANSWERS

1 - (9702/21_Summer_2017_Q1) - *Physical Quantities & Units, Measurement Techniques*

(a)	(stress =) force / area or kg m s^{-2} / m^2
	= kg m^{-1} s^{-2}
(b)(i)	$0.58 = 2\pi \times [(4 \times 0.500 \times 0.600^3) / (E \times 0.0300 \times 0.00500^3)]^{0.5}$
	$E = [4\pi^2 \times 4 \times 0.500 \times (0.600)^3] / [(0.58)^2 \times 0.0300 \times (0.00500)^3]$ $= 1.35 \times 10^{10}$ (Pa)
	= 14 (13.5) GPa
(b)(ii)1.	(accuracy determined by) the closeness of the value(s)/measurement(s) to the true value
	(precision determined by) the range of the values/measurements
(b)(ii)2.	*l* is (cubed so) 3 × (percentage/fractional) uncertainty and *T* is (squared so) 2 × (percentage / fractional) uncertainty and (so) *l* contributes more

2 - (9702/22_Summer_2017_Q1) - *Physical Quantities & Units, Measurement Techniques*

(a)	kelvin, mole, ampere, candela *any two*
(b)	use of resistivity = *RA* / *l* **and** *V* = *IR* (to give $\rho = VA / Il$)
	units of *V*: (work done / charge) kg m^2 s^{-2} (A s)$^{-1}$
	units of resistivity: (kg m^2 s^{-3} A^{-1} A^{-1} m) = kg m^3 s^{-3} A^{-2}
	or
	use of $R = \rho L / A$ and $P = I^2R$ (gives $\rho = PA / I^2L$)
	units of *P*: kg m^2 s^{-3}
	units of resistivity: (kg m^2 s^{-3} × m^2) / (A^2 × m) = kg m^3 s^{-3} A^{-2}
(c)(i)	$\rho = (RA / l)$
	$= (0.03 \times 1.5 \times 10^{-6}) / 2.5$ $(= 1.8 \times 10^{-8})$
	= 18 nΩ m
(c)(ii)	**1.** precision is determined by the range in the measurements/values/readings/data/results
	2. metre rule measures to ± 1 mm and micrometer to ± 0.01 mm (so there is less (percentage) uncertainty/random error)

3 - (9702/23_Summer_2017_Q1) - *Physical Quantities & Units*

(a)(i)	R = 7(.0) N
(a)(ii)	R = 13 N
(b)(i)	forces resolved: 18 sin 65° (vertical) **and** 55 + 18 cos 65° (horizontal) **or** scale drawing: correct triangle drawn for forces
	$F = [(18 \sin 65°)^2 + (55 + 18 \cos 65°)^2]^{1/2}$ = 65 (64.7) N **or** scale drawing: scale given, length of resultant given correctly, ± 1 N
(b)(ii)	angle = $\tan^{-1}$ [18 sin 65° / (55 + 18 cos 65°)] = $\tan^{-1}$ (16.3 / 62.6) **or** scale drawing: correct angle measured/direction correct on diagram below the 55 N force
	angle = 15 (14.6)° (below the 55 N force) **or** scale drawing: angle = 15° ± 1°
(c)	(resultant) force = mass × acceleration
	80 – 65 = 2.7a
	a = 5.6 m s^{-2} [5.7 if 64.7 N used from **(i)**]

4 - (9702/21_Winter_2017_Q1) - *Physical Quantities & Units, Kinematics, Dynamics*

(a)	units of F: kg m s^{-2}	**C1**
	units of ρ: kg m^{-3} **and** units of v: m s^{-1}	**C1**
	units of K: kg m s^{-2} / [kg m^{-3} (m s^{-1})^2] = m^2	**A1**
(b)(i)	$K\rho$ = 1.5 / 33^2	**C1**
	= 1.38 × 10^{-3} F_D = 1.38 × 10^{-3} × 25^2 **or** F_D / 1.5 = 25^2 / 33^2 F_D = 0.86 N	**A1**
(b)(ii)	a = (1.5 – 0.86) / (1.5 / 9.81) **or** a = 9.81 – [0.86 / (1.5 / 9.81)]	**C1**
	a = 4.2 m s^{-2}	**A1**
(c)	initial acceleration is g/9.81 (m s^{-2})/acceleration of free fall	**B1**
	acceleration decreases	**B1**
	final acceleration is zero	**B1**

5 - (9702/23_Winter_2017_Q1) - *Physical Quantities & Units*

(a)(i)	work (done) / time (taken) or energy (transferred) / time (taken)	**B1**
(a)(ii)	Correct substitution of base units of all quantities into any correct equation for power. Examples: ($P = E / t$ or W / t gives) kg m^2 s^{-2} / s = kg m^2 s^{-3} ($P = Fs / t$ or mgh / t gives) kg m s^{-2} m / s = kg m^2 s^{-3} ($P = ½mv^2 / t$ gives) kg (m s^{-1})^2 / s = kg m^2 s^{-3} ($P = Fv$ gives) kg m s^{-2} m s^{-1} = kg m^2 s^{-3} ($P = VI$ gives) kg m^2 s^{-3} A^{-1} s^{-1} A = kg m^2 s^{-3}	**A1**
(b)(i)	units of A: m^2 and units of T: K	**C1**
	units of k: kg m^2 s^{-3} / m^2 K^4 = kg s^{-3} K^{-4}	**A1**
(b)(ii)	curve from the origin with increasing gradient	**B1**