GCSE
PHYSICS

Topic Paper: 5.4 Moments, levers and gears (physics only)
Part 1, 2 & 3 Mark Scheme

MARK SCHEME

128 Marks

M21.   (a)   suspend shape from a point / pivot / pin

                can be shown on labelled diagram

                                                                    1

        attach pendulum (bob) / plumb line to point of suspension

                                                                      1

        draw (vertical) line on card where string rests

                                                                      1

        suspend card from another point and draw (a second vertical) line on card where string rests

                                                                      1

        where two lines cross = centre of mass

                *alternative method max **3** marks:*

                balance card on a point (1)

                find point where card rests horizontally (1)

                this point is the centre of mass (1)

                                                                      1

     (b) (i) (the line of action of) the weight acts / lies outside the base

                reference to centre of mass unqualified is insufficient

                                                                     1

         there will be a resultant moment

                references to stability insufficient

                                                                       1

        (ii) move the wheels further apart

                answers must be comparative to diagram

                accept any method that would give a wid<u>er</u> base

                accept tilt the wheels

                accept on own, make a wider base but not wider seat

                                                                     1

         lower the seating position

                accept any method that would lower the centre of mass, eg place heavy mass under the chair

                accept on own make it have a low<u>er</u> centre of mass

                make wheelchair heavier on its own is insufficient

                                                                      1

                                                                               [9]

M1. 300

　　　　　　　*allow **1** mark for rearranging equation **or** correct substitution*

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[2]

M2. (a) any **two** ideas:

　　　　　(acceleration occurs when) the direction (of each capsule) changes

　　　　　velocity has direction

　　　　　acceleration is (rate of) change of velocity

　　　　　　　　　　　　　　　　　　　　　　　　　　　　2

　　(b) to(wards) the centre (of the wheel)

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　(c) centripetal

　　　　　　*allow minor misspellings but do **not** credit a response which could be 'centrifugal'*

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　(d) the greater the radius / diameter / circumference (of the wheel)
　　　　　the smaller the (resultant) force (required)

　　　　　　　accept 'the size'
　　　　　　　both parts required for the mark
　　　　　　　accept converse

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　[5]

M3. (a) (line of action of) its weight

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　falls inside its wheel base

　　　　　　accept 'falls between the wheels'
　　　　　　*the first **two** points may be credited by adding a vertical line from the centre of the X on the diagram (1)*
　　　　　　and labelling it weight / force / with a downwards arrow (1)
　　　　　　provided there is no contradiction between what is added to the diagram and anything which may be written

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

　　(so there is) no (resultant / clockwise) moment / turning effect

　　　　　　　　　　　　　　　　　　　　　　　　　　　　1

(b) centre of mass should be lower

> *accept '… centre of gravity'*
> *accept 'weight / mass low down'*
> **not** *just 'lower the roof'*

1
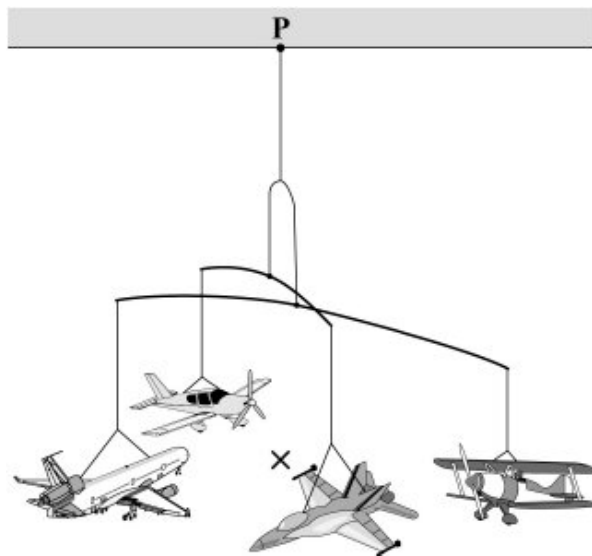
wheel base should be wider

> *accept 'long axle(s)' for 'wide wheel base'*
> *allow bigger / larger wheel base*
> *do **not** credit 'long wheel base'*
> *responses in either order*

1

[5]

M4. (a) (i) centre of **X** directly below **P** and between the model aeroplanes

> *as judged by eye but between centre of propeller of top aeroplane*
> *and canopy of bottom aeroplane*
> *example*

1

(ii) the centre of mass is (vertically) below the point of suspension / P

1

the centre of mass is in the middle of the aeroplanes

> *accept the centre of mass is level with the aeroplanes*

1

(b) centre of mass of the worker and the ladder (and device)

1

line of action of the weight is inside the base

accept the centre of mass is above / within / inside the base (of the ladder and device)

1

so there will not be a (resultant) moment

accept so he / it / the ladder will not topple even if he leans over

or it will (only) topple over if the line of action of the weight / the centre of mass is outside the base

*accept each point, either on the diagram or in the written explanation, but do **not** accept the point if there is any contradiction between them*

1

[6]

M5. (a) (from present/recent) data/evidence/observations of (the rate of change in) Phobos'/the moon's orbit (1)

or appropriate example of data (1)

and its correct use (1)

(and) continued/extended/extrapolated (the pattern/trend for the next 100 million years) (1)

example (present) distance from Phobos to Mars (1)
÷(average) rate of approach (1)

2

(b) (it is) increasing (1)

Phobos/the moon will be nearer (to Mars) (1)

or the radius/circumference/diameter of the orbit of Phobos/the moon will decrease/be less

only credit 2nd mark if the first mark is correct

2

(c) it will increase/be more (1)

(because) Phobos/the moon will get/be closer to Mars/the planet (1)

only credit 2nd mark if the first mark is correct

note part(s) of this response may be included as the answer to part (b)

read both before marks are awarded

2

[6]

M6. (a) 560

*allow **1** mark for*
clockwise (moments) = anticlockwise (moments)
*allow **1** mark for correct substitution*
ie 160 ×1.75 = W ×0.5
*allow **1** mark for correct transformation*
ie $\dfrac{160 \times 1.75 = W}{0.5}$

4

newtons, N

1

(c) the we<u>ight of</u> plank which has been ignored

1

causes an anticlockwise moment which has not been
considered / included in the calculation

1

[7]

M7. (a) where the mass of the object can be thought to be concentrated

1

(b) lower the C of M

1

and make the wheelbase wider

1

accept a practical description of how these changes could be
achieved

(c) the line of action of its weight
*accept a vertical arrow drawn from **X***

2

falls inside its wheel base
accept falls between the wheels

therefore there is no resultant / clockwise moment

1

[6]

M8. (a) the direction of the riders is constantly changing

1

therefore the velocity of the riders is changing

1

and because acceleration is the rate of change of velocity
the acceleration is changing

1

(b) to(wards) the centre (of the cylinder / rotor)

1

(b) centripetal

1

(b) it is reduced

1

[6]

M9. (a) 38 400

*allow 6.4 ×6000 for **1** mark*

2

Nm **or** newton metres

*do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN_

*allow **1** mark for 38 400 ÷2.4*
*accept their (a) ÷2.4 correctly calculated for **2** marks*
*accept their (a) ÷2.4 for **1** mark*

2

[5]

M10. (a) the point at which the (total) mass seems to act / appears to be concentrated

accept 'weight' for 'mass'
accept the point at which gravity seems to act
*do **not** accept a definitive statement eg where (all) the mass is*

1

(b) wider / larger base

marks are for a correct comparison

1

lower centre of mass

accept lower centre of gravity / c of g

1

(c) line of action (of the weight) lies / falls inside the base

in each case the underlined term must be used correctly to gain the mark

1

the resultant moment returns mixer to its original position

accept there is no resultant moment / resultant moment is zero

accept resulting moment for resultant moment

do not accept converse argument

1

[5]

M11.(a) (i)will not fall over (1)

accept will not easily fall over (2)

or

centre of mass will remain above the base (1)

(line of action of the) weight will remain above within the base

accept centre of gravity / c of g / c of m / c m

if the monitor is given a small push (1)

depends on mark above

2

(ii)(total) clockwise moment = (total) anticlockwise moment

or they are equal / balanced

1

(b) the position of the centre of mass has changed (1)

the line of action of the weight is outside the base (1)

producing a (resultant) moment (1)

points may be expressed in any order

3

[6]

M12. (a) 1.2

*allow **1** mark for conversion of 2.4 kN to 2400 N*

or for correct transformation without conversion

ie d = 2880 ÷2.4

2

metre(s)/m

1

8

(b) any **two** from:

as the load increases the (total) clockwise moment increases

danger is that the fork lift truck / the load will topple / tip forward

(this will happen) when the total clockwise moment is
    equal to (or greater than) the anticlockwise moment
        accept moments will not be balanced

(load above 10.0 kN) moves line of action (from C of M)
    outside base (area)

        2

            [5]

M13. (a) (i) current produces a magnetic field (around XY)
        accept current (in XY) is perpendicular to the (permanent)
        magnetic field

        1

(creating) a force (acting) on XY / wire / upwards
        reference to Fleming's left hand rule is insufficient

        1

(ii) motor (effect)

        1

(iii) vibrate / move up and down

        1

5 times a second
    only scores if first mark point scores
    *allow for **1** mark only an answer 'changes direction 5 times a*
    second'

        1

(b) 0.005
    *allow **1** mark for calculating moment of the weight as 0.04 (Ncm)*
    and
    *allow **1** mark for correctly stating principle of moments*
    or
    *allow **2** marks for correct substitution*
    *ie F ×8 = 2 ×0.02   **or** F ×8 = 0.04*

        3

            [8]

M14. (a) 960 (Nm)

        1

see-saw is in equilibrium

> *accept see-saw is balanced*
>
> *see-saw is stationary is insufficient*

1

(total) clockwise moments = anticlockwise moment

> *accept no resultant moment*
>
> *forces are balanced is insufficient*
>
> *an answer clockwise moments balance the anticlockwise moments gains **2** marks*

1

(b)(i) 600 (Nm)

1

(ii)375 (N) **or** their (b)(i) ÷1.6 correctly calculated

> *do **not** credit if (b)(i) is larger than 960*
>
> *allow **1** mark for correct substitution **and** transformation ie*
>
> $\dfrac{600}{1.6}$ or $\dfrac{their\ (b)(i)}{1.6}$

2

[6]

M15. (a) any **two** from:

(acceleration occurs when) the direction (of each capsule) changes

velocity has direction

acceleration is (rate of) change of velocity

2

(b) to(wards) the centre (of the wheel)

1

(c) the greater the radius / diameter / circumference (of the wheel) the smaller the (resultant) force (required)

> *accept 'the size' for radius*
>
> *both parts required for the mark*

1

[4]

M16. (a) 38 400

> *allow 6.4 ×6000 for **1** mark*

2

Nm **or** newton metres

> *do **not** credit 'nm', 'mN' or 'metre newtons'*

1

(b) 16 000 (N) **or** 16 kN_

        *allow **1** mark for 38 400 ÷2.4*

        *accept their (a) ÷2.4 correctly calculated for **2** marks*

        *accept their (a) ÷2.4 for **1** mark*

        2

        [5]

M17.   (a) 60

        *allow **1** mark for correct substitution (with d in metres),*
        ie 36 = F ×0.6

        *an answer of 0.6 **or** 6 gains **1** mark*

        2

(b) the line of action of the weight lies outside the base / bottom (of the bag)

        accept line of action of the weight acts through the side

        accept the weight (of the bag) acts outside the base / bottom
        (of the bag)

        1

       a resultant / overall / unbalanced moment acts (on the bag)

        accept the bag is not in equilibrium

        *do **not** accept the bag is unbalanced*

        1

(c) 0.0625

        *allow **1** mark for correct substitution, ie $16 = \dfrac{1}{f}$*

        *an answer of 0.00625 gains **1** mark*

        2

       hertz / Hz

        *do **not** accept HZ **or** hz*

        1

        [7]

M18.   (a) centripetal (force)

        allow tension (between astronaut and seatbelt)

        1

       towards the centre (of the G-machine / circle)

        *do **not** accept towards the centre of the Earth*

        allow inwards

        1

(b) (i) the greater the <u>speed</u> (of a centrifuge), the greater the <u>force</u>

        answers must be comparative

        accept velocity for speed

        accept positive correlation between speed and force

        speed and force are not proportional – treat as neutral

        1

the small<u>er</u> the radius, the great<u>er</u> the force (at a given speed)

> *allow **(G machine) 1** has / produces a great<u>er</u> force (than*
> ***G machine 2**) at the same speed*
> *must be comparative, eg a small radius produces a large force = 0*
> *marks on own*

1

as the speed increases the rate of change in force increases

> *accept force is proportional to the square of the speed*
> ***or***
> *doubling speed, quadruples the force*
> *accept any clearly correct conclusion*

1

(ii) 12000 (N)

or

12 k(N)

1

(c) (i) the current (in the coil) creates a magnetic field (around the coil)

> *accept the coil is an electromagnet*

1

so the magnetic field of the coil interacts with the (permanent) magnetic field of the magnets (producing a force)

> *accept the two magnetic fields interact (producing a force)*
> *if no marks scored an answer in terms of current is perpendicular*
> *to the (permanent) magnetic field is worth max **1** mark*

1

(ii) vertically downwards arrow on side A

> *one arrow insufficient*

and

vertically upwards arrow on side C

1

(iii) the current is parallel to the magnetic field

> *allow the current and magnetic field are in the same direction*
> *allow it / the wire is parallel to the magnetic field*

1

(d) increase the current / p.d. (of the coil)

> *accept decrease resistance*
> *accept voltage for p.d.*
> *accept increase strength of magnetic field / electromagnet*

1

(e) yes with suitable reason

> **or**

no with suitable reason

> > *eg*
> >
> > *yes – it has increased our knowledge*
> >
> > *yes – It has led to more (rapid) developments / discoveries (in technology / materials / transport) accept specific examples*
> >
> > *no – the money would have been better spent elsewhere on such things as hospitals (must quote where, other things not enough)*
> >
> > *no mark for just yes / no*
> >
> > *reason must match yes / no*

1

[12]

M19.   (a) (i)liquids are (virtually)

incompressible

1

(b) 84

> *allow **1** mark for correct substitution, ie*
>
> $$1.5 \times 10^{6} = \frac{F}{5.6 \times 10^{-5}}$$
>
> *numbers may not be written in standard form, ie*
>
> $$1\,500\,000 = F \frac{F}{0.000\,056}$$
>
> *allow **1** mark for an answer 216*

2

(c) it (the force on the slave pistons) is greater / larger

> *accept force (at slave piston) = 216 (N)*

1

the area (touching the liquid) of the slave piston is greater than the area of the master piston

> *accept it has a bigger area*
>
> *just quoting numbers, eg the master piston is 5×10^{-5} and the slave piston is 14.4×10^{-5} is insufficient*

1

[5]

M20.   (a) hydraulic (system)

1

(b) 15.40 $\times 10^2$
or
1540

allow 1 mark for correct substitution, ie

$8.75 \times 10^4 = \dfrac{F}{1.76 \times 10^{-2}}$

or

$87\,500 = \dfrac{F}{0.0176}$

or

$F = 8.75 \times 10^4 \times 1.76 \times 10^{-2}$

or

$F = 87\,500 \times 0.0176$

2

(c) any **one** environmental **advantage**:

stating a converse statement is insufficient, or a disadvantage of the usual oil, ie the usual oil is non-renewable

plant oil is renewable

using plant oil will conserve (limited) supplies **or** extend lifetime of the usual / crude oil.

plant oil releases less carbon dioxide (when it is being produced / processed)

plant oil will add less carbon dioxide to the atmosphere (when it is being produced / processed, than the usual oil)

plant oil removes carbon dioxide from **or** adds oxygen to the air when it is growing

stating that plant oil is carbon neutral is insufficient

1

(d) (the current flowing through the coil) creates a magnetic field (around the coil)

1

(this magnetic field) interacts with the permanent magnetic field
or
current carrying conductor is in a (permanent) magnetic field

it must be clear which magnetic field is which

1

this produces a (resultant) force (and coil / cone moves)

1

when the direction of the current changes, the direction of the force changes to the opposite direction

accept for 2 marks the magnetic field of the coil interacts with the permanent magnetic field

1

[8]